PROGRAMMING AND SERVICE MANUAL

MODEL 3495A
SCANNER

Serial Number: 03495A00101 (See Note below.)

IMPORTANT NOTICE

This loose leaf manual does not normally require a change sheet. All major change information has been integrated into the manual by page revision. In cases where only minor changes are required, a change sheet may be supplied.

If the Serial Number of your instrument is lower than the one on this title page, the manual contains revisions that do not apply to your instrument. Backdating information given in the manual adapts it to earlier instruments.

Where practical, backdating information is integrated into the text, parts list and schematic diagrams. Backdating changes are denoted by a delta sign. An open delta (Δ) or lettered delta (Δ_A) on a given page, refers to the corresponding backdating note on that page. Backdating changes not integrated into the manual are denoted by a numbered delta (Δ_1) which refers to the corresponding change in the Backdating section (Section VIII).

WARNING

To help minimize the possiblity of electrical fire or shock hazards, do not expose this instrument to rain or excessive moisture.

Manual Part No. 03495-90012

Microfiche Part No. 03495-90062

P.O. Box 301, Loveland, Colorado, 80537 U.S.A.

Printed: November 1977

HEWLETT hp PACKARD

CERTIFICATION

Hewlett-Packard Company certifies that this instrument met its published specifications at the time of shipment from the factory. Hewlett-Packard Company further certifies that its calibration measurements are traceable to the United States National Bureau of Standards, to the extent allowed by the Bureau's calibration facility, and to the calibration facilities of other International Standards Organization members.

WARRANTY AND ASSISTANCE

This Hewlett-Packard product is warranted against defects in materials and workmanship for a period of one year from the date of shipment, except that in the case of certain components, if any, listed in Section I of this operating manual, the warranty shall be for the specified period. Hewlett-Packard will, at its option, repair or replace products which prove to be defective during the warranty period provided they are returned to Hewlett-Packard, and provided the proper preventive maintenance procedures as listed in this manual are followed. Repairs necessitated by misuse of the product are not covered by this warranty. NO OTHER WARRANTIES ARE EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. HEWLETT-PACKARD IS NOT LIABLE FOR CONSEQUENTIAL DAMAGES.

If this product is sold as part of a Hewlett-Packard integrated instrument system, the above warranty shall not be applicable, and this product shall be covered only by the system warranty.

Service contracts or customer assistance agreements are available for Hewlett-Packard products.

For any assistance, contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont'd)

LIST OF TABLES

LIST OF ILLUSTRATIONS

LIST OF ILLUSTRATIONS (Cont'd)

SECTION I
GENERAL INFORMATION

1-1. INTRODUCTION.

1-2. This Operating and Service Manual contains information required to install, operate, test, adjust, and service the Hewlett-Packard Model 3495A Scanner.

1-3. INSTRUMENTS COVERED BY MANUAL.

1-4. Attached to the instrument is a serial number plate. The serial number is in the form: 0000A00000. It is in two parts; the first four digits and the letter are the serial prefix and the last five digits are the suffix. The prefix is the same for all identical instruments; it changes only when a change is made to the instrument. The suffix,however, is assigned sequentially and is different for each instrument. The contents of this manual apply to instruments with the serial number prefix(es) listed under SERIAL NUMBERS on the title page. The letter separating prefix and suffix designates the country in which the instrument was manufactured. (A = U.S.A.; G = West Germany; J = Japan; U = United Kingdom.)

1-5. Also listed on the title page of this manual is a microfiche part number. This number can be used to order 4 X 6-inch microfilm transparencies of the manual. Each microfiche contains up to 96 photo-duplicates of the manual pages. The microfiche package also includes the latest Manual Changes supplement as well as pertinent Service Notes.

1-6. MANUAL CHANGES.

1-7. As errata and instrument changes accumulate, manual changes may become necessary. Accumulated change information is generally incorporated into the manual by means of a yellow manual change supplement or set of revised pages.

1-8. The manual change supplement is identified by the manual print date and part number which the supplement applies to. Both of these are located on the manual title page. We suggest that you periodically request this complimentary supplement to keep your manual up-to-date.

1-9. Revised pages are identified with a revision letter next to the page number. Sets of revised pages are accompanied by an updated manual revision index and title page.

1-10. SAFETY CONSIDERATIONS.

1-11. All safety information in this manual is identified by a **NOTE, CAUTION,** or **WARNING** safety heading. These headings contain important information and should be interpreted as follows:

> NOTE: An operating procedure, condition, etc., which is essential or important.
>
> CAUTION: An operating procedure, practice, etc., which must be strictly complied with to avoid damage or destruction to equipment.
>
> WARNING: An operating procedure, practice, etc., which must be strictly complied with to avoid injury or death to personnel.

1-12. DESCRIPTION.

1-13. The Model 3495A Scanner is a versatile HP–IB system instrument that may be loaded with a combination of four Low Thermal and Actuator channel options. Fourteen 3495A's with four options each may be operated by a controller such as the Model 9820A, Model 9830A, or Model 9825A Calculator on the Hewlett-Packard Interface Bus (HP–IB) to provide up to 1120 separately programmable channels. The Model 3495A Scanner may listen on the HP–IB but not talk.

NOTE

One 3495A must be removed for each additional instrument on the bus.

1-14. The Low Thermal decade is a ten-to-one analog multiplexers allowing the signals to be monitored by one measurement instrument in a break-before-make sequence. An uncertainty differential thermal EMF of less than 2 μV may be expected on a channel. Hardware assurance of break-before-make switching of 200 multiplexed low thermal channels is possible by interconnecting five 3495A's at the rear panels and positioning internal jumper wires. Software can assure a like situation for all 560 channels.

1-15. The Actuator decade option relays have two sets of normally-open contacts with four terminals per channel. Any number of channels may be closed simultaneously as needed for power or signal distribution, control functions, etc.

1-16. The Thermocouple decade option is similar to the Low Thermal decade option except that a thermocouple reference connector is substituted for the terminal connector. Nine multiplexed temperature measurements can be made per option. Channel 0 on each connector is reserved for a reference temperature monitoring thermistor.

1-17. The low thermal duo-decade options are 20-to-1 multiplexers, allowing 20 signals (42 V max) to be monitored by one measurement instrument. A scanner loaded with four duo-decade options has 80 programmable channels.

1-18. The thermocouple duo-decade option is similar to the low-thermal duo-decade option except that channel O on each connector is reserved for a reference temperature monitoring resistor.

1-19. Both duo-decade options are capable of a switching speed up to 1000 channels per second when used as the sole options in the 3495A Scanner or when slower options have no clear addresses.

1-20. The high speed controller option replaces the standard interface and control assembly with a high speed unit. The A8 version can control channel switching at the maximum logic assembly rates through provisions for software controlled and external increment/decrement.

1-21. SPECIFICATIONS.

1-22. **Specifications are performance characteristics which are warranted.** Table 1-1 lists the specifications for the -hp- Model 3495A Scanner. These specifications supersede all others. Any changes in specifications due to manufacturing or design changes are included in Table 1-1. These specifications apply to a fully covered scanner with properly installed options and accessories with the rear 3495A door closed.

Table 1-1. Specifications.

Option 001, Accessory 44401A 10 Channel Low Thermal Relay Assembly (Decade)

Type: Three pole, low thermal dry reed relays per channel. Third pole switches guard and is not low thermal. Break-before-make operation with partially sequenced closure: (Guard closes before low and high relays close. Guard opens after low and high relays open).

Maximum Contact Ratings:
Voltage: 200 V peak
Current: 200 mA (non-inductive)
Power: 2 VA

Maximum Input Voltages:
Between any two terminals: 230 V peak
Guard to chassis: 200 V peak
Guard to low: 200 V peak

Thermal Offset: < 2 μV differential EMF

Isolation: > 10^{10} Ω between high, low, guard

Switching Time: 10 msec maximum

Option 002, Accessory 44402A 10 Channel Relay Actuator Assembly (Decade)

Type: Two pole armature relay with two normally open contacts per relay. Single unswitched guard for 10 channels. Any combination of 10 channels may be closed or opened simultaneously.

Maximum Contact Ratings:
Voltage: 100 V rms
Current: 2 A rms
Power: 200 VA

Maximum Input Voltage:
Between any two terminals: 230 V peak
Guard to chassis: 200 V peak
Guard to low: 200 V peak

Thermal Offset: < 30 μV differential EMF

Switching Time: 40 msec maximum

CAUTION

For circuits fused at 2 amps or less and less than 200 VA capacity.

Option 003, Accessory 44403A 9 Channel Reference Junction Relay Assembly (Decade)

Type: Three pole, low thermal dry reed relays. Third pole switches guard and is not low thermal. Break-before-make operation with partially sequenced closure. (Guard closes before low and high relays close. Guard opens after low and high relays open.) Up to 9 channels of thermcouple connections. Remaining channel measures reference temperature.

Maximum Contact Ratings:
Voltage: 42 V peak
Current: 200 mA (non-inductive)
Power: 2 VA

Maximum Input Voltage:
Between any two terminals: 42 V peak
Guard to chassis: 200 V peak

Thermal Offset (ambient temperature ± 1°C): < 2 μV differential EMF

Isolation: > 10^7 Ω between high, low, guard

Switching Time: 10 msec maximum

Option 004, Accessory 44404A 20 Channel Low Thermal Relay Assembly

Type: Three pole, low thermal dry reed relays per channel. One pole is guard. Break before make.

Maximum Contact Ratings:
Voltage: 42 V peak
Current: 40 mA (non-inductive)
Power: 1 VA

Maximum Input Voltages:
Between any two terminals: 42 V peak
Guard to chassis: 42 V peak

Thermal Offset (ambient temperature ± 1°C): < 1 μV differential EMF

Isolation: > 10^7 Ω between high, low, guard

Switching Time: 1 msec maximum

Table 1-1. Specifications (Cont'd).

Option 005, Accessory 44405A Reference Junction Relay Assembly — 19 Channels

Type: Three pole, low thermal dry reed relays per channel. One pole is guard. Break-before-make. Up to 19 channels of thermocouple connections. Remaining channel measures reference temperature.

Maximum Contact Ratings:
Voltage: 42 V peak
Current: 40 mA (non-inductive)
Power: 1 VA

Maximum Input Voltages;
Between any two terminals: 42 V peak
Guard to chassis: 42 V peak

Thermal Offset (ambient temperature ± 1°C): < 1 μV differential EMF

Isolation: > 10^7 Ω between high, low, guard

Switching Time: 1 msec maximum

Option 100, Accessory 44413A High Speed Scanner Controller

Adds high speed capability to the 3495A. Used with Option 004 or 005 to provide a sequenced scan of up to 1000 channels/second for one 3495A. Synchronization is achieved with a trigger cable connection between the high speed scanner and a measuring instrument such as the Hewlett-Packard 3437A System Voltmeter.

AC Performance

	Opt. 001 10 Channel Low Thermal	Opt. 002 10 Channel Actuator	Opt. 004 20 Channel Low Thermal
High-to-Low Channel Capacitance Open: Closed:	 < 15 pF < 15 pF	 < 15 pF < 25 pF	 < 350 pF < 400 pF
Interchannel Capacitance	< 12 pF	< 12 pF	< 10 pF
Frequency Response (10 kHz reference, 50 Ω load)	Up to 100 kHz: ± 0.3 dB Up to 1 MHz: ± 0.5 dB	Up to 100 kHz: ± 0.3 dB Up to 1 MHz: ± 0.5 dB	Up to 1 MHz: ± 0.20 dB
Cross Talk Open Channel Termination 50 Ω 1 MΩ	 100 kHz 1 MHz < -70 dB < -50 dB < -33 dB < -30 dB	 100 kHz 1 MHz < -70 dB < -50 dB < -30 dB < -30 dB	 100 kHz 1 MHz < -70 dB < -50 dB < -50 dB < -50 dB

Temperature Performance — Option 003, 005, Accessories 44403A, 44405A Reference Junction Relay Assemblies

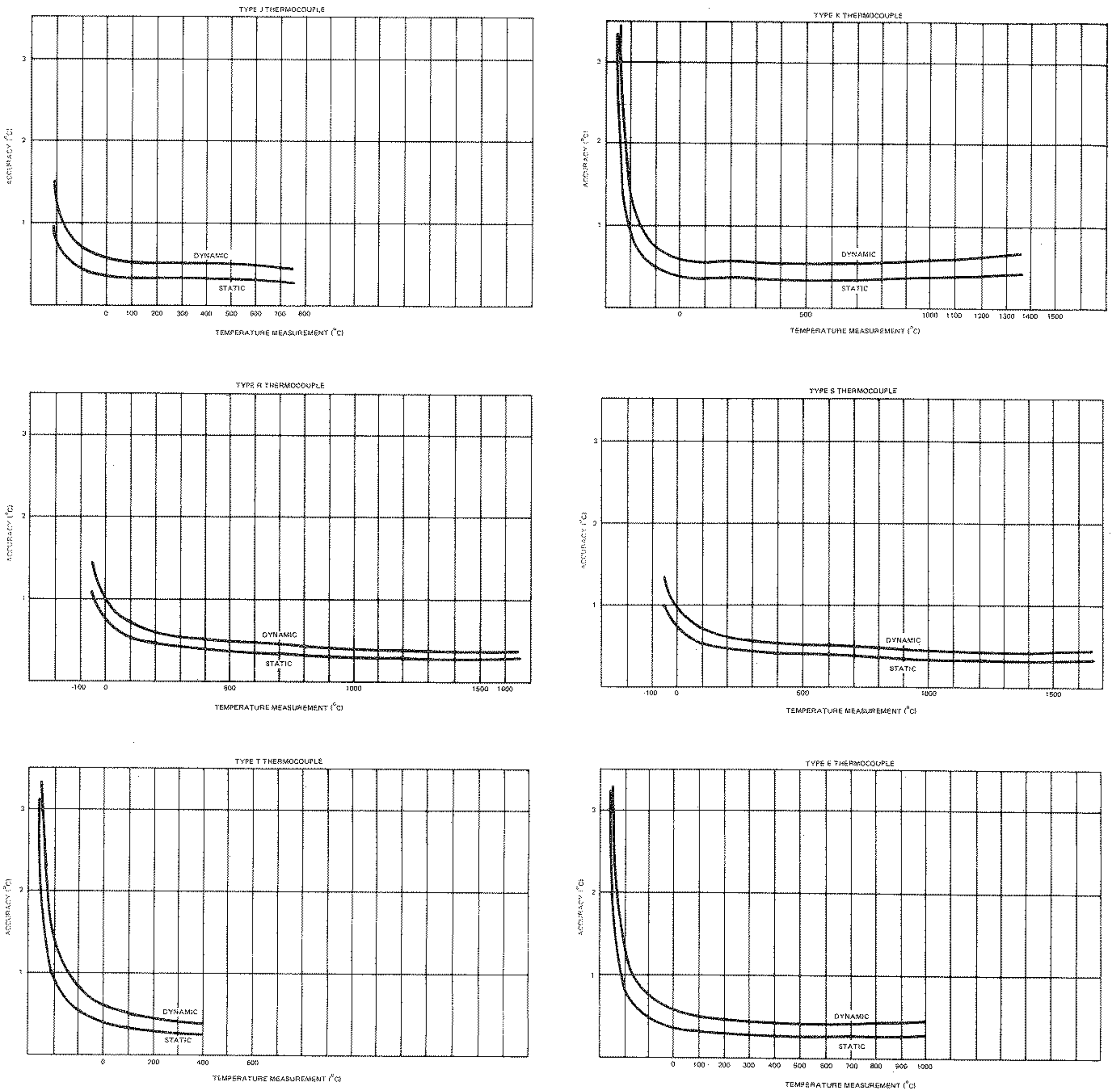
Thermistor Accuracy: ± 0.2°C

Temperature Gradient Along Terminals From Thermistor:
Steady State[1]: 0.1°C Maximum
Dynamic[2]: 0.3°C Maximum

Thermocouple Measurement Accuracy: The following graphs represent performance for various types of thermocouples under steady state and dynamic conditions. The accuracy includes such errors as thermistor accuracy, temperature gradients, thermal offset, thermistor curve fit accuracy and thermistor lead resistance.

[1] Applies to ambient temperature ± 1°C deviations
[2] Applies to ambient temperature step of 5°C or 5°C/hour maximum rate of change

Table 1-1. Specifications (Cont'd).



Accuracy curves reflect the following representative sources of error:

Reference Temperature Errors	Measurement Errors
Thermistor Accuracy -2 Ω lead resistance -.01°C curve fit	2 μV Scanner Offset Voltage (3495A)
Temperature Gradients Along Terminals from thermistor - static environment	

1-23. The environmental conditions listed in Table 1-2 must be present for the -hp- Model 3495A to meet stated specifications. Some definitions are helpful.

a. **Steady-State Environment**: An environment where the ambient temperature varies no more than 1 degree centigrade at once (±1°C).

b. **Dynamic Environment**: An environment where the ambient temperature varies no more than 5 degrees centigrade at once (±5°C) or where the rate of change of ambient temperature is no more than 5 degrees centigrade per hour (±5°C/hour).

1-24. SUPPLEMENTAL CHARACTERISTICS.

1-25. Supplemental characteristics are intended to provide information useful in applying the 3495A and interpreting specifications. These include typical performance parameters. Table 1-2 lists supplemental characteristics for the -hp- Model 3495A Scanner.

Table 1-2. Supplemental Characteristics.

Environmental Requirements

Storage Temperature: –40°C to +75°C
Operating Temperature: 0 to 55°C, < 95% RH at 40°C

Power:
100/120/220/240 volts +5%, –10%
48 to 66 Hz line
< 100 VA

Dimensions:
190.5 mm (7.5 in) high
428.6 mm (16.88 in) wide
520.7 mm (20.5 in) deep

Weight: Depends on options

Temperature Gradient along terminals from thermistor	Option 003	Option 005
Static[1]:	.1°C	.1°C
Dynamic[2]:	.3°C	.3°C

Reference Thermistor Accuracy ⩽0.2°C

[1] Applies to ambient temperature ± 1°C deviations
[2] Applies to ambient temperature step of 5°C or 5°C/hour maximum rate of change

MESSAGE TRANSFER RATES

Message		Typical Handshake Times (µsec/Byte) A8	A4
Commands			
Selected Device Clear (SDC)		*	*
Group Execute Trigger (GET)		75	2
Device Clear (DCL)		*	*
My Listen Address (MLA)		53	2
Unlisten Address (UNL)		53	2
Instructions			
Digits:			
0		116	3
1		116	3
2		118	3
3		118	3
4		120	3
5		120	3
6		122	3
7		122	3
8		124	3
9		124	3
Space (SP)		60	3
Clear	C	*	*
Execute (CR)	E	(84)86	3
External Increment	I	124	–
Off	Ø	126	–
On	1	126	–
First Channel	F	120	–
Last Channel	L	124	–
Software Increment	S	**	–
No Operator (NUL, DEL)		52	2
		38	2
Delimiter All Others		124	3

– Act as delimiters
* Equivalent to slowest installed option switching time
** Equivalent to switching time of the option the increment occurs on plus 80 µsec.

1-26. OPTIONS.

1-27. The standard 3495A does not include any channels. It must be loaded with one through four low thermal, actuator, or thermocouple options. These are supplied one per option purchased. 44401A, 44402A, 44403, 44404A, and 44405A are field-installable versions of options 001, 002, 003, 004, and 005 respectively. The following is a list of options available for the -hp- Model 3495A Scanner.

Option 001–One Low Thermal Decade (Includes A5, A10, A13, A14 assemblies).

Option 002–One Actuator Decade (Includes A6, A20, A22, A23 assemblies).

Option 003–One Low Thermal Decade with Thermocouple Reference Connector (Includes A5, A10, A13, A24 assemblies).

Option 004–One Low Thermal Duo-Decade (Includes A5, A40, A25, A45 assemblies).

Option 005–One Low Thermal Duo-Decade with Thermocouple Reference Connector (Includes A5, A40, A25, A46 assemblies).

Option 100–High Speed Controller Option (Substitutes A8 for A4).

Option 907–Front Handle Kit, part number 5061-0090.

Option 908–Rack Mount Cabinet Assembly, part number 5061-0078.

Option 909–Cabinet Assembly (Option 907 and Option 908 combined) part number 5061-0084.

Option 910–An additional Operating and Service Manual, part number 03495-90012.

1-28. ACCESSORIES AVAILABLE.

1-29. The following accessories are available for the -hp- Model 3495A Scanner:

-hp- Model No.	Shown in Figure	Description
44401A	1-1	Field Installable Low Thermal Decade (001)
44402A	1-2	Field Installable Actuator Decade (002)
44403A	1-3	Field Installable Thermocouple Decade (003)
44404A	1-4	Field Installable Low Thermal Duo-Decade (004)
44405A	1-5	Field Installable Thermocouple Decade (005)
44413A	1-6	Field Installable High-Speed Controller (100)
44095A	1-7	Service Kit
03495-84411		An additional Access Kit
10503A		BNC-to-BNC cable (48") for Break-Before-Make synchronization of two scanners

1-30. The Service Kit is a field service kit designed to facilitate on-site isolation and repair of failures in the -hp- Model 3495A Scanner. A description of this kit is in the Service section of the manual.

1-31. The Access Kit provides an extension to connector J1B of the A1 mother board for monitoring and testing. One extender board is provided with the basic scanner.

1-32. The cable accessory may be used to connect two scanners via the rear panel SYNC jacks. Break-before-make

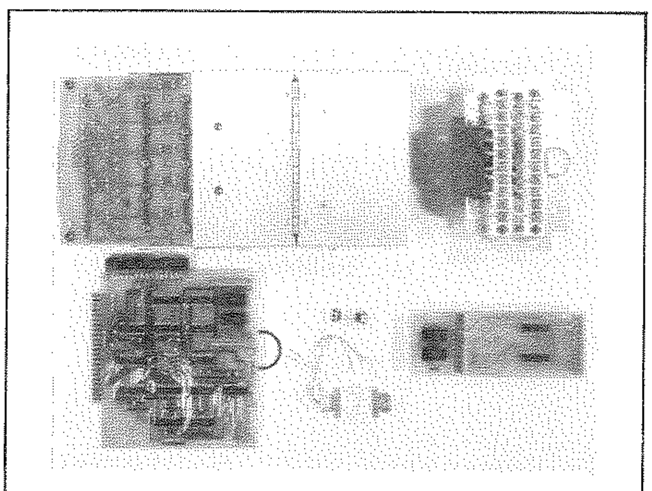


Figure 1-1. Field Installable Low Thermal Decade.

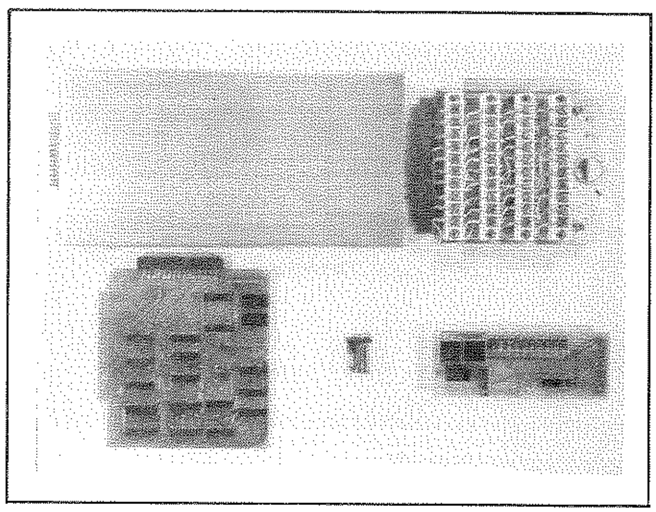


Figure 1-2. Field Installable Actuator Decade.

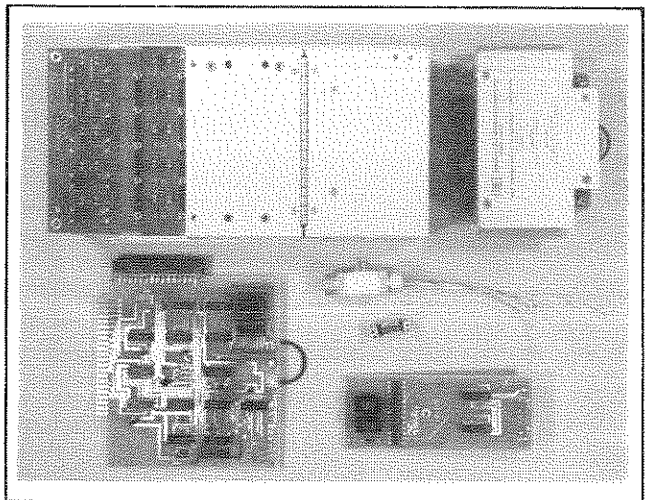


Figure 1-3. Field Installable Thermocouple Decade. (Reference Junction Assembly)

synchronization is possible for up to five scanners connected in this manner.

1-33. Individual terminal assemblies are available as follows:

03495-64101	Low Thermal Decade
03495-64102	Actuator Decade
03495-64103	Thermocouple Decade
03495-64114	Low Thermal Duo-Decade
03495-64115	Thermocouple Duo-Decade

1-34. MANUAL STRUCTURE.

1-35. This manual is structured to simplify operating and servicing of the -hp- Model 3495A Scanner. Information necessary to operate the scanner is located towards the front of the manual. Information necessary to troubleshoot and repair the scanner is located in the service group sections towards the rear of the manual.

1-36. Scanner operating information includes general information and descriptions, installation, hardware and software programming, testing, adjustments, and a generalized parts list. This information is included for all scanner option/accessory combinations.

1-37. Service information is assembled in service "groups" which cover the available sets of assemblies that normally require service in the scanner. Each service group section contains theory, troubleshooting information, parts lists, schematics, component locators, and functional block diagrams. Table 1-3 lists the service group description and options covered for each service group.

1-38. Each service group is a self sufficient service section on a particular set of scanner assemblies, options, or accessories. Refer to the appropriate service group if servicing in these areas is required.

Table 1-3. Service Group Descriptions.

Service Group	Description	Option/Accessory
A	Basic Scanner	Standard
B	Low Thermal Decade Option **Or** Reference Connector Duo-Decade Option	001/44401A 003/44403A
C	Actuator Decade Option	002/44402A
D	Low Thermal Duo-Decade Option **Or** Reference Connector Duo-Decade Option	004/44404A 005/44405A
E	Fast Controller Option (Includes SA Testing)	100/44413A

WARNING

Service groups contain information for use only by trained service personnel. Attempts to service the scanner by other than trained service personnel may result in personal injury and/or damage to the scanner.

1-39. Operating and programming information is contained in the first five (5) sections of the manual. Refer to these sections for information regarding setting up and using the Model 3495A Scanner. These sections also contain descriptions of scanner specifications, capabilities, performance tests, and applications.

1-40. Information on specific controller programming of the -hp- Model 3495A Scanner is included as appendices to this manual. A generalized programming model is developed in Section III to aid in translating your controller's language into scanner control programs.

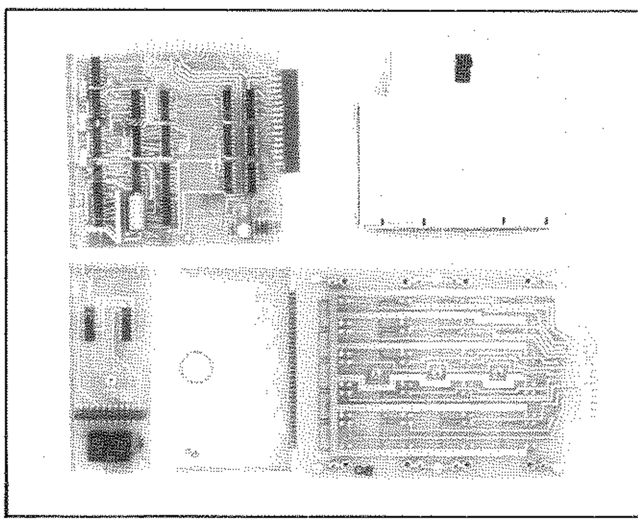


Figure 1-4. Field Installable Low Thermal Duo-Decade.

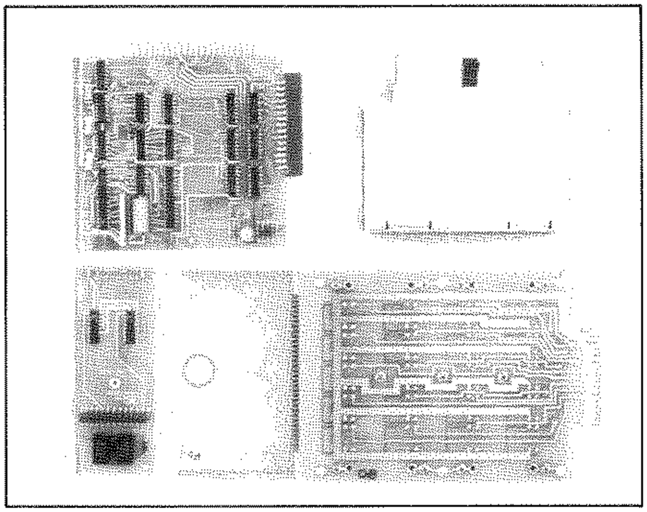


Figure 1-5. Field Installable Thermocouple Duo-Decade. (Reference Junction Assembly)

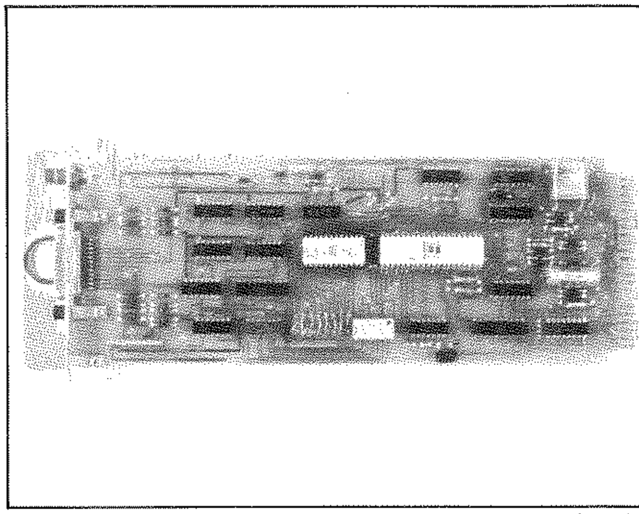
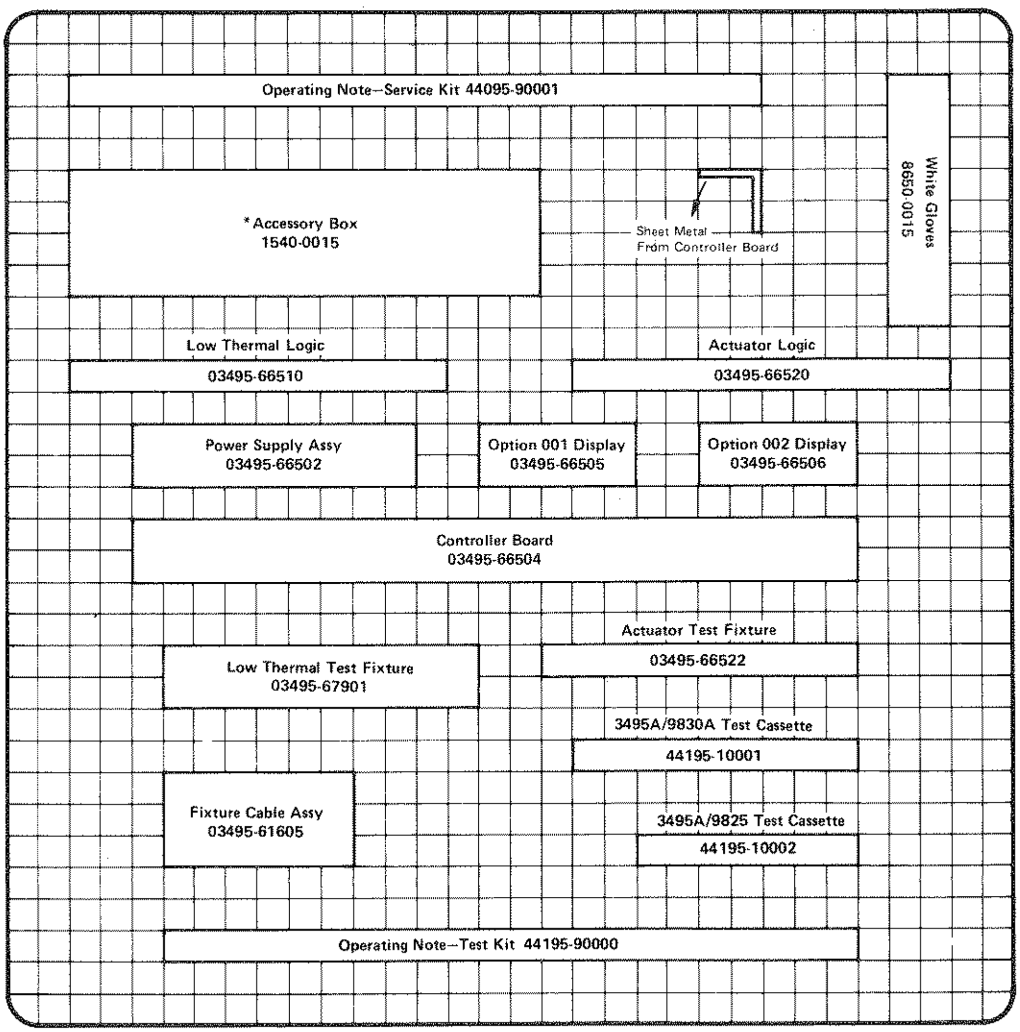


Figure 1-6. Field Installable High-Speed Controller (100).



*Accessory Box Contains:

A13R10	03495-82600
A13R11	03495-82601
A11KØ9A	0490-1111
A11KØ9B	0490-1109
A21KØ–9	0490-0563
A6DSØ–9	1990-0419
Terminal	0360-0617

Figure 1-7. Service Kit.

1-41. COMPLETING THE LOOP.

1-42. More information on available parts, documentation and service aids can be obtained through your local -hp- Sales and Service Office. Appendix C lists -hp- offices by location.

Table 1-4. Support Documentation.

-hp- Support Document	Document Type & Brief Description
44401-90000	Operating Note for -hp- 3495A Options 001,002 & Accessories 44401A, 44402A
44403-90002	Operating Note for -hp- 3495A Option 003 & Accessory 44403A
44404-90000	Operating Note for -hp- 3495A Option 004 & Accessory 44404A
44405-90000	Operating Note for -hp- 3495A Option 005 & Accessory 44405A
44413-90000	Operating Note for -hp- 3495A Option 100 & Accessory 44413A
44095-90002	Operating Note for -hp- 3495A Service Kit 44095A/B
44195-90000	Operating Note for -hp- 3495A Test Kit 44195A
P-03495-64103-1B	Part Note for -hp- 3495A Reference Junction Connector 03495-64103 supplied with Option 003

SECTION II
INSTALLATION

2-1. INITIAL INSPECTION.

2-2. This instrument was carefully inspected both mechanically and electrically before shipment. It should be free of mars or scratches and in perfect electrical order upon receipt. To confirm this, the instrument should be inspected for physical damage incurred in transit. If the instrument was damaged in transit, file a claim with the carrier. Check for accessories supplied (Section I). If there is damage or deficiency, see the warranty in the front of this manual.

2-3. POWER REQUIREMENTS.

2-4. The Model 3495A can be operated from any power source supplying 100 V, 120 V, 220 V or 240 V (−10% + 5%), 48 Hz to 66 Hz. Power dissipation is 100 VA, maximum. Refer to Section III for Instrument Turn-On procedure.

CAUTION

The two line voltage selector switches on the rear panel must be positioned for the proper line voltage before instrument turn on. See Figure 2-3 for location of these switches.

2-5. POWER CORDS AND RECEPTACLES.

2-6. Figure 2-1 illustrates the standard configurations used for -hp- power cords. The -hp- part number directly below each drawing is the part number for an instrument power cord equipped with a connector of that configuration. If the appropriate power cord is not included with the instrument, notify the nearest -hp- Sales and Service Office and a replacement cord will be provided.

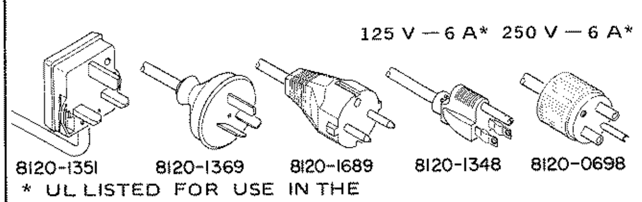


Figure 2-1. Power Cord Receptacles.

2-7. GROUNDING REQUIREMENTS.

2-8. To protect operating personnel, the National Electrical Manufacturer's Association (NEMA) recommends that the instrument panel and cabinet be grounded. The Model 3495A is equipped with a three conductor power cable which, when plugged into an appropriate receptacle, grounds the instrument. The offset pin on the power plug is the ground connection.

2-9. To preserve the protection feature when operating the instrument from a two-contact outlet, use a three-contact to two-contact adapter and connect the wire on the adapter to power-line ground.

2-10. Additional safety ground points are provided at the four tapped 6-32 holes at the rear corners of the instrument.

2-11. ENVIRONMENTAL REQUIREMENTS.

2-12. For the 3495A to meet the specifications listed in Table 1-1, the operating temperature must be within the range of +0°C to +55°C (+32°F to 131°F). Additional environmental conditions for Option 003 are explained in Section III Applications, Temperature Measurements. The storage temperature range with any option is from −40°C to +70°C (−10°F to +158°F). The rear door should be kept closed to reduce heat transfer.

2-13. INSTALLATION.

2-14. Bench Use.

2-15. The Model 3495A is shipped with plastic feet which are shaped to permit the instrument to be placed on top of other full-module Hewlett-Packard instruments.

2-16. Rack Mounting.

2-17. The Model 3495A may be rack mounted using the rack mount kit. Option 908, part number 5061-0078. The rack mount is an EIA standard width of 19 inches; height is 7 inches. When rack mounted, additional support must be provided at the rear of the instrument.

2-18. INSTALLATION OF OPTIONS.

2-19. Table 2-1 lists the factory installed locations and address values for the 3495A channel options.

2-20. Options 001, 002, 003, 004, 005, and 100 are available as field installable accessories. Before installation of these accessories, review Section III, Hardware Programming and Applications for some considerations and examples of wiring the connectors to best suit your needs.

2-21. After determining channel connections, addressing schemes, and guard connections for each decade accessory, the terminal assemblies may be wired.

2-22. Wiring the A14 Terminal Assembly (Option 001).

2-23. Four terminal strips on the A14 Terminal Assembly

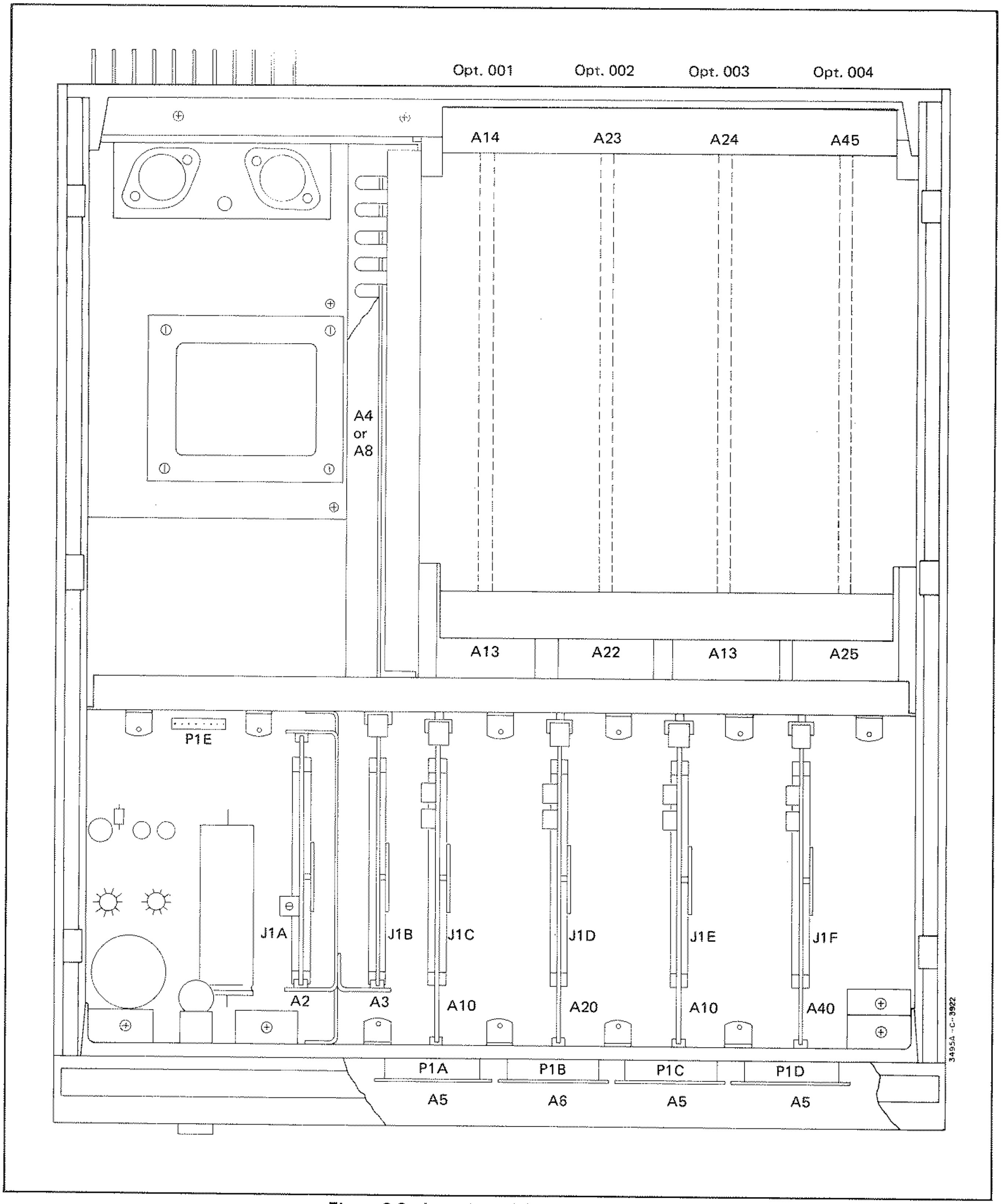


Figure 2-2. Location of Option Assemblies.

Table 2-1. Factory Installation of Options.

Option	Location	Close Address	Clear (Open) Address
001 002 003	Left Right Left	0 through 3 Left to Right	≠Close Address None ≠Close Address
004 005	Right Left	0, 2, 4, 6 Left to Right	≠Close Address ≠Close Address

(two per side) provide connection points for ten channels of High, Low, and Guard lines. Two sets of common terminals (one per side) are also available on the assembly. The terminal assignments are shown in Section VII, Service Group B.

2-24. To connect wires to the terminals, follow this procedure:

a. Loosen the terminal set screw.

b. Strip approximately 3/16 inch insulation from the wire to be connected.

CAUTION

Bare wire lengths should be kept to a minimum to avoid shorted lines.

c. Insert the bare wire end into the proper terminal.

d. Tighten the terminal set screw to secure the connection.

e. Verify that the connection is secured.

f. Repeat A–E for all the wires to be connected to the terminals.

2-25. Guard lines are connected to guard terminals in a similar manner. If guard connections are not made at the point of measurement, a Guard Common to Low Common connection is needed. Guarding principles are discussed in Section III, Guarding.

2-26. Wiring the A23 Terminal Assembly (Option 002).

2-27. Four terminal strips on the A23 Terminal Assembly (all four on the front side) provide connection points for ten channels of A and B lines. Two guard terminals are also available on the assembly. The terminal assignments are shown in Section VII, Service Group C.

2-28. To connect wires to the terminals, follow the procedure given for the Low Thermal Terminal Assembly.

2-29. Two threaded standoffs on the (A23) Terminal Assembly are provided for making guard connection. Stripped guard wires may be connected to these standoffs with standard 8/32 screws.

2-30. Wiring the A24 Thermocouple Reference Connector (Option 003).

2-31. Three terminal strips arranged on the front side of the connector PC board provide connection points for ten channels of High, Low, and Guard lines. Channel Ø is tied to a temperature sensing thermistor, leaving nine (9) channels for thermocouple wires. Two additional terminal strips on the front side of the connector PC board provide two sets of common terminals. The terminal assignments are shown in Section VII, Service Group B.

2-32. To connect thermocouple wires to the terminals on the thermocouple reference connector, follow this procedure:

a. Remove the metal plate on the front of the connector, by removing the four retaining screws.

b. Loosen the terminal set screw.

c. Guide the thermocouple wire to be connected into the connector thru one of the baffles.

d. Insert the thermocouple wire into the proper terminal.

e. Tighten the terminal set screw to secure the connection.

f. Verify that the connection is secured.

g. Repeat A – F for all the thermocouple wires to be connected.

h. If guard connections to the points of measurement are not made, connect Guard Common to Low Common on either side of the connector with 18 AWG or greater wire.

i. Replace the front metal plate with the retaining screws.

2-33. Wiring the A45 and A46 Terminal Connectors (Options 004 and 005).

2-34. The twenty-channel terminal connectors are wired in a method similar to the ten-channel connectors. Installation procedures for these options or accessories should be followed to insure proper channel activity. The terminal assignments for the twenty-channel connectors are shown in Service Group E.

2-35. Install any combinations of options in the four available positions according to the following procedure:

a. Disconnect the power cord.

b. Remove the top cover by turning the screw at the

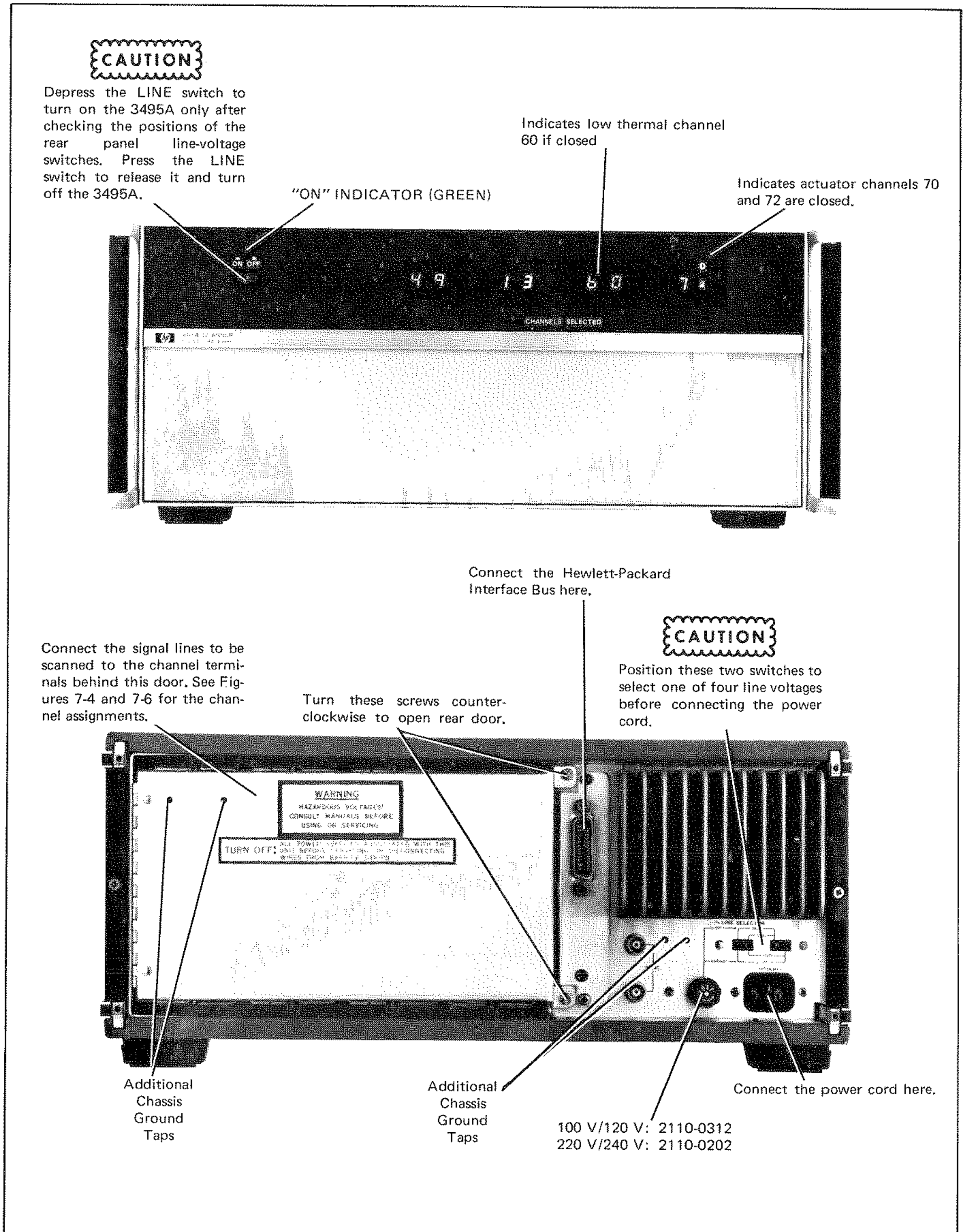


Figure 2-3. Front and Rear Views.

rear of the cover and pulling backwards on the cover.

c. Remove the front panel by loosening the four screws securing the panel at the horizontal tabs behind the panel. Move the panel forward and off the instrument by pushing on the tabs. Do not drop the panel!

d. Install the A5 Low Thermal and A6 Actuator Display assemblies in any order desirable on the four printed circuit extensions at the front of the instrument. Secure them with one screw each into the standoffs.

e. Slide the A10 Low Thermal, A20 Actuator, and A40 Duo-Decade Logic assemblies into the guides and jacks behind the A5, A6, and A5 assemblies respectively.

CAUTION

A10 and A40 must be behind A5, and A20 must be behind A6.

f. Open the door on the rear of the instrument by turning the two screws on the door. See Figure 2-3 for location of these screws.

g. Slide the A13 Low Thermal Channel and A22 Actuator Channel assemblies into the rear of the instrument so that they plug into the A10 and A20 assemblies respectively.

CAUTION

A13 must plug into A10, and A22 into A20. Be sure that the P13 male connector has pin guards (-hp- Part Number 03495-22100) installed to prevent damage to channel and terminal assembly connectors!

h. Push the wired A14 and A24 Terminal Assemblies onto the A13 Relay Assemblies. Push the wired A23 Terminal Assemblies onto the A22 Relay Assemblies. Be sure that all assemblies are firmly in place.

CAUTION

Clean handling techniques are required when handling the 44401A printed circuit assembly.

NOTE

Installation of the Relay Assemblies locks the Logic Assemblies into place until removal of the respective Relay Assemblies.

i. Replace the front panel, top cover and door.

2-36. INTERFACE CONNECTION.

2-37. Connect each 3495A to the Hewlett-Packard Interface Bus at the rear panel jack.

2-38. Figure 2-4 shows the pin configuration of the HP–IB connector on the 3495A Scanner.

2-39. The maximum total length of HP–IB cable in any system must not exceed 20 meters or 2 meters per device, whichever is less.

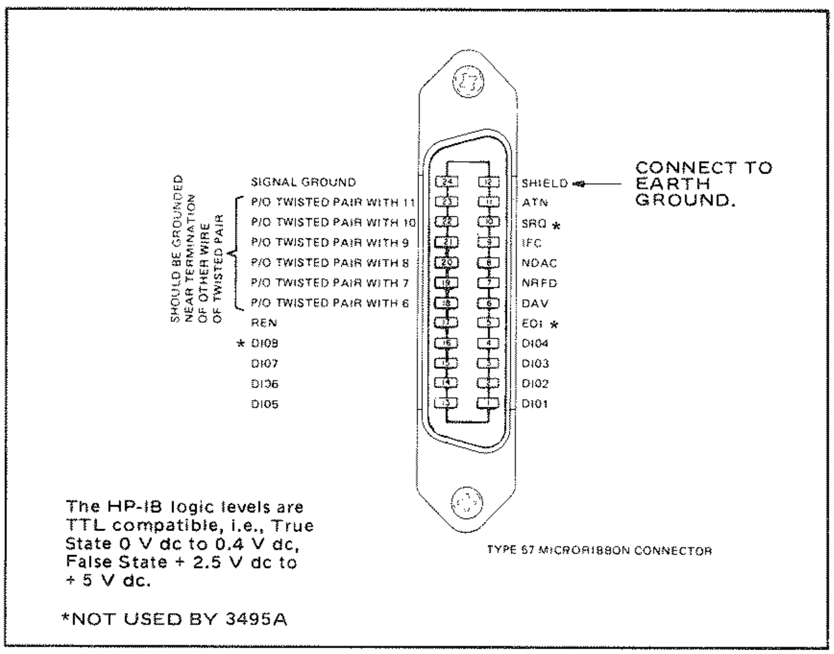


Figure 2-4. HP–IB Connector.

2-40. REPACKAGING FOR SHIPMENT.

NOTE

If the instrument is to be shipped to Hewlett-Packard for service or repair, attach a tag to the instrument identifying the owner and indicating the service or repair to be accomplished. Include the model number and full serial number of the instrument. In any correspondence, identify the instrument by model number and full serial number. If you have any questions, contact your nearest -hp- Sales and Service Office.

2-41. The following is a general guide for repackaging the instrument for shipment. If the original container is available, place the instrument in the container with appropriate packing material and seal well with strong tape or metal bands. If the orignal container is not available, proceed as follows:

a. Wrap instrument in heavy paper or plastic before placing in an inner container.

b. Place packing material around all sides of instrument and protect panel face with cardboard strips or plastic foam.

c. Place instrument and inner container in a heavy carton and seal with strong tape or metal bands.

d. Mark shipping container "DELICATE INSTRUMENT", "FRAGILE", etc.

SECTION III
OPERATING INSTRUCTIONS

3-1. INTRODUCTION.

3-2. This section describes the operation and control of the -hp- Model 3495A Scanner. Keep in mind that the 3495A can only open and close relays. The efficiency of the scanner is determined by *how* it's set up and programmed, and the system it's used in. The versatility of the scanner necessitates discussion of hardware programming, software control over the Hewlett-Packard Interface Bus (HP–IB), theory of operation, and applications with specific controllers and channel options. A thorough understanding of these areas will help you determine the "BEST" way to set up and use the 3495A for your application.

3-3. Turn On.

CAUTION

Make sure the rear panel line voltage selector switches are set for the proper 100 V, 120 V, 220 V, or 240 V configuration and the proper fuse is installed BEFORE turning on the 3495A.

3-4. Depress the front panel line switch to turn on the 3495A. A green "ON" indicator is located above the line switch on scanners with Serial Numbers 1428A01626 and above. On earlier scanners, a green tab inside the line switch flips down to indicate turn on.

3-5. Turn Off.

3-6. Press and release the front panel line switch to run off the 3495A.

3-7. FUNCTIONAL DESCRIPTION.

3-8. The following paragraphs describe the basic operation of the 3495A decade options.

3-9. Low Thermal Decades (Options 001 and 003). [B]

3-10. The channel terminal assignments and relay configurations are shown in Figure 7-B-21 of Service Group B. Channels are arranged as ten per option (a decade). Low thermal decades are ten-to-one multiplexers with one set of common terminals. Signals are multiplexed to the common terminals one-at-a-time in a break-before-make sequence. This means that a previously closed channel in a decade opens before the new channel closes.

3-11. Guard relays close before and open after the High/Low relays on each channel. Common terminals of low thermal decades in one or more 3495A's may be connected.

3-12. The front panel displays indicate channel conditions on a decade. A closed channel is indicated by the two-digit number displayed on the decade's display. Low thermal decade displays are shown in Figure 2-3 of Section II.

3-13. Actuator Decades (Option 002). [C]

3-14. The channel terminal assignments and relay configurations for Actuator decades are shown in Figure 7-C-13 of Service Group C. Actuator channels are arranged ten per option (a decade) and consist of two sets of normally open contacts with four terminals per channel. Actuator channels are not sequenced and any number of channels per decade may be closed at the same time.

NOTE

The Scanner exhibits a maximum switching time of 40 msec with clear addresses installed into this option.

3-15. Closed Actuator channels are indicated by the channel numbers displayed on the decade's display. The Actuator display consists of a ten's channel digit and corresponding unit's channel LED's. An Actuator display is shown in Figure 2-3 of Section II.

3-16. Low Thermal Duo-Decades (Options 004 and 005). [D]

3-17. The channel terminal assignments and relay configurations for the duo-decade options are shown in Figure 7-D-9 of Service Group D. Low thermal duo-decades are twenty-to-one multiplexers with one set of common terminals. Signals are multiplexed to the common terminals one-at-a-time in a break-before-make sequence. This means that a previously closed channel in a decade opens before the new channel closes.

3-18. The duo-decade options provide for operation of the full 80 channel capacity of the 3495A. Synchronous operation and selectable relay open and close timers allow for burst channel closures of more than 1000 per second. A high speed DVM with a reading rate exceeding this must be used to make measurements at this speed (such as the -hp- Model 3437A).

3-19. The high-speed capability of the duo-decade options combined with increased channel capacity make duo-

decade options well suited for multi-channel burst measurements and other high speed applications.

3-20. HARDWARE PROGRAMMING.

3-21. Optimizing the 3495A Scanner for a particular application is accomplished through a series of three hardware programming features:

a. The physical selection of channel hookups on the terminal assemblies.

b. The selection of decade and duo-decade (open) close and clear addresses by positioning internal jumper wires.

c. The selection of the 3495A's Listen Address on the Hewlett-Packard Interface Bus by positioning internal jumper wires.

3-22. CHANNEL HOOKUP.

3-23. In some applications, the proper selection of channels may reduce the amount of software needed for data manipulation. If the physical (space) or sequential (time) relationships between measurements are important, assign channels with this in mind.

3-24. The most obvious way of selecting channel hookups is to assign measurements which are adjacent physically or sequentially to adjacent 3495A channels. This "duplicates" the relationship between measurements.

3-25. DECADE ADDRESSES (Options 001, 002, 003).

NOTE

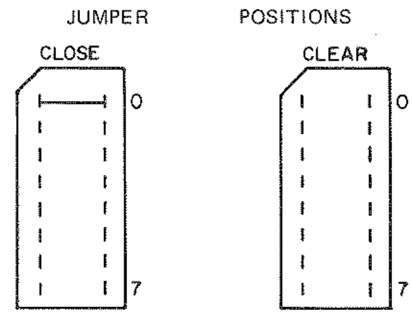
The terms "clear" and "open" have near equivalent meanings in this manual. "Clear" is used explicitly for decade options. "Open" is used explicitly for duo-decade options.

3-26. A system of hardware Close and Clear addresses for channel decades provides considerable versatility in operating the 3495A. Channels are programmed by sending two-digit instructions to the 3495A: a ten's channel digit and a unit's channel digit. Each decade may be hardware programmed to respond to a specific ten's channel digit of 0 through 7 by positioning jumper wires on the logic assemblies. The 8 possible decade addresses provide 80 possible channel numbers from 00 through 79. Separate jacks are provided for decade Close and Clear addresses.

NOTE

Each 3495A with decade options has up to 80 channel addresses but a maximum 40 channels.

3-27. A decade address "SENSITIZES" a decade to respond to a ten's channel digit of a channel programming instruction. The decade Close address(es) select the ten's channel digit(s) that close channel(s) on that decade. The decade Clear address(es) select the ten's channel digit(s) that open all the channels on that decade. The following examples illustrate the jumper positions, resulting Close and Clear addresses, and channel response to instructions:



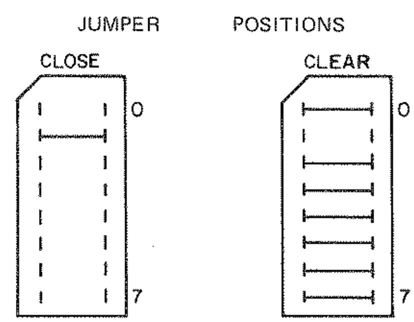
CLOSE ADDRESSES: 00–09

CLEAR ADDRESSES: NONE

CHANNEL ACTIVITY

The channel(s) on this decade will close on channel instructions of 00 thru 09.

Channel instructions for other decades will NOT affect the channels on this decade.



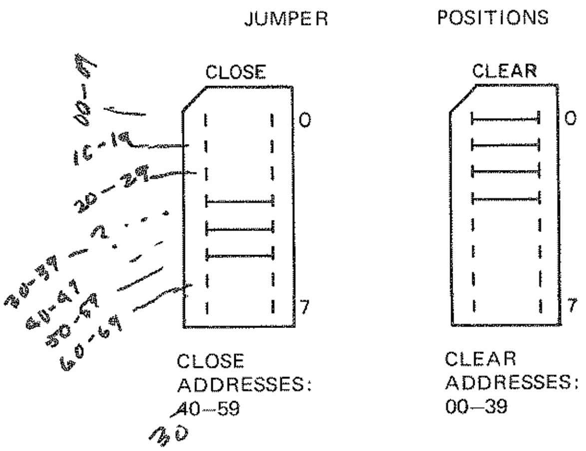
CLOSE ADDRESSES: 10–19

CLEAR ADDRESSES: 00–09, 20–79

CHANNEL ACTIVITY

The channel(s) on this decade will close on channel instructions of 10 thru 19.

Channel instructions for other decades will clear this decade.



CHANNEL ACTIVITY

This channel(s) on this decade will close on channel instructions of 40 thru 59. Using a 4X or 5X instruction is immaterial since 41 will close the same channel as 51.

Channel instructions from 00 thru 39 will clear this decade.

3-28. Selecting Decade Addresses.

3-29. Factory installed decades are given non-overlapping Close addresses of 00–39, depending on the number of decades installed. Low Thermal decades are given 7 Clear addresses not corresponding to the Close address. Actuator decades have NO Clear addresses wired.

3-30. If you intend to modify the decade Close and Clear addresses of your 3495A, you must first remove the factory installed jumpers. Install jumpers in the Close address position(s) you want that decade to respond to. Next install jumpers in the Clear address position(s) you want to clear that decade. Figure 3-1 illustrates six decade addressing schemes.

> Example: A Logic assembly may have a Close address of 0 and 1; and a second Logic assembly, a Close address of 0 and a Clear address of 1. When channel number 05 is programmed and executed, channel 5 closes on both Logic assemblies; but when channel number 15 is programmed and executed, channel 5 closes on the first Logic assembly, and all channels open on the second Logic assembly.

3-31. A pair of 3495A's (with decade options only) can be hardware programmed to act as one unit by assigning Close addresses of 0 through 3 to one scanner and 4 through 7 to the other. If both scanners have the same Listen address, they act as one 80 channel scanner.

3-32. Up to five 3495A's loaded with low thermal decades can be connected to act as a maximum 200-to-1 multiplexer. This can be done as follows:

a. Assign each 3495A pair the same Listen address.

b. Assign the remaining 3495A a unique Listen address.

c. Connect the Common terminals of all 20 decades.

d. Assign decade Close addresses of 0 through 8 to each scanner pair.

e. Assign each decade, seven Clear addresses not corresponding to its Close address.

f. Connect the SYNC jacks of each scanner.

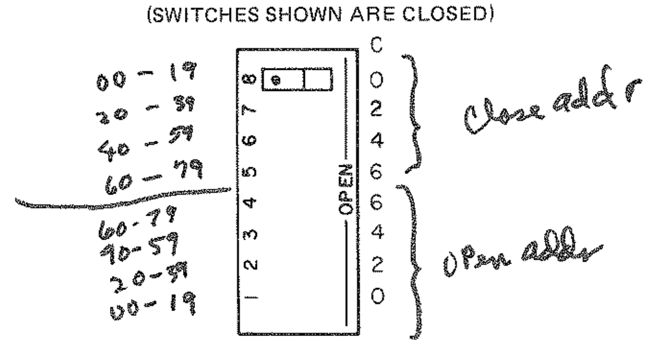
3-33. DUO–DECADE ADDRESSES (Options 004, 005).

3-34. Close and Open addresses for channel duo-decades are set on the duo-decade logic assembly. An 8 switch DIP (S1) can be positioned to provide any combination of close or open addresses as follows:

Duo-Decade Address Blocks
00–19
20–39
40–59
60–79

3-35. A duo-decade address "sensitizes" a duo-decade to respond to a block of twenty channel programming instructions. The "close" response is the closure of the desired relay(s) in the selected block or blocks. The "open" response is the opening of all relays in the selected block or blocks (twenty per open address). The following examples illustrate the switch positions, resulting close and open addresses, and channel response to instructions.

SWITCH POSITIONS
(SWITCHES SHOWN ARE CLOSED)



CHANNEL ACTIVITY

The channel(s) on this duo-decade will close on channel instructions of 00 through 19.

Channel instructions for other duo-decades will NOT affect the channels on this duo-decade.

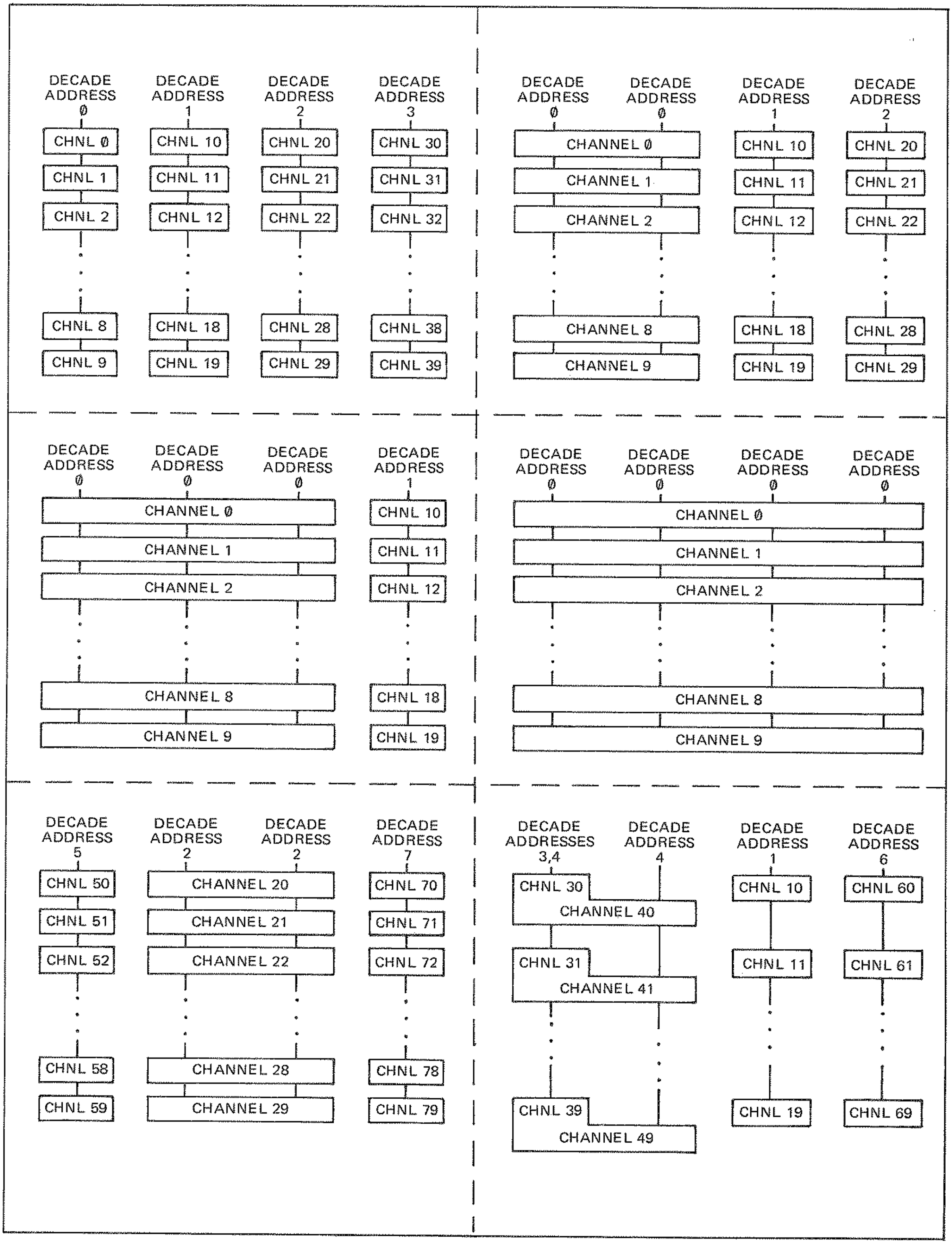
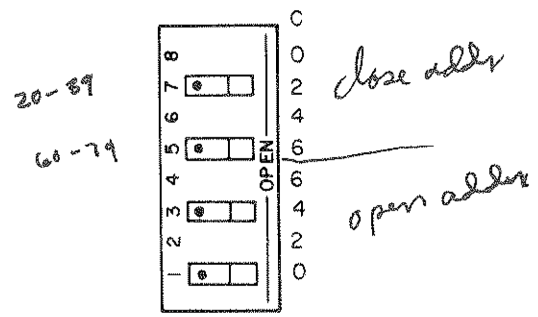


Figure 3-1. Some Decade Address Possibilities.

SWITCH POSITIONS
(SWITCHES SHOWN ARE CLOSED)



CHANNEL ACTIVITY

The channels on this duo-decade will close on channel instructions of 20 through 39, and 60 through 79.

Channel instructions for other duo-decades will open the channels on this duo-decade.

3-36. Selecting Duo-Decade Addresses.

3-37. The duo-decade addresses are easily set or changed on the DIP switch S1.

NOTE

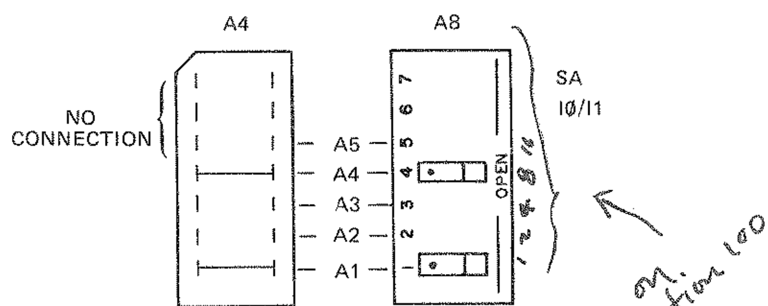
The switching speed of the 3495A is determined by the slowest *option installed with clear (open) addresses. Duo-decades will not operate at their maximum speed in a mixed option 3495A unless the slower options have* no *clear addresses installed.*

3-38. LISTEN ADDRESS.

3-39. Further versatility in the operation of the 3495A is provided by hardware assignment of the 3495A's HP–IB Listen address on the A4 or A8 assembly. Any number of 3495A's may be given the same or different addresses. Different addresses among the 3495A's are generally used to give the maximum number of unique channels. Identical addresses may be used for multiple-wire scanning.

3-40. Selecting a Listen Address.

3-41. A Listen address must be selected for each 3495A on the HP–IB by placing jumpers in the A4 Address jack or A8 dip switch, corresponding to the five least significant binary bits, DIO5 through DIO1, of any character in Table 3-1. A closed switch is a logic level "1", an open switch, "0". A jumper in the jack is logic level "1"; a jumper out, "0". The numbering of the bits is from right to left on the jack. The last two of the seven positions are ignored on the A4 assembly and used for initializing the external increment capability and implementing signature analysis tests on the A8 assembly. Closing these switches enables the external increment and SA test capabilities on the A8 assembly. Right parenthesis,), is the Listen address used in all examples in this manual and is the address set at the factory. This is illustrated below:



LISTEN ADDRESS

DIO7 THRU DIO1: 01 01001

ASCII CHARACTER:)

NOTE: SWITCHES SHOWN ARE CLOSED.

Table 3-1. My Listen Addresses.

MLA	HPIB DATA BITS DIO7 THRU DIO1	DEC-IMAL	MLA	HPIB DATA BITS DIO7 THRU DIO1	DEC-IMAL
SP	0100000	32	0	0110000	48
!	0100001	33	1	0110001	49
"	0100010	34	2	0110010	50
#	0100011	35	3	0110011	51
$	0100100	36	4	0110100	52
%	0100101	37	5	0110101	53
&	0100110	38	6	0110110	54
'	0100111	39	7	0110111	55
(	0101001	40	8	0111000	56
)[1]	0101010	41	9	0111001	57
*	0101010	42	:	0111010	58
+	0101011	43	;	0111011	59
,	0101100	44	<	0111100	60
–	0101101	45	=	0111101	61
.	0101110	46	>	0111110	62
/	0101111	47			

NOTE: The Listen addresses are ASCII characters.

[1]: This is the factory selected value.

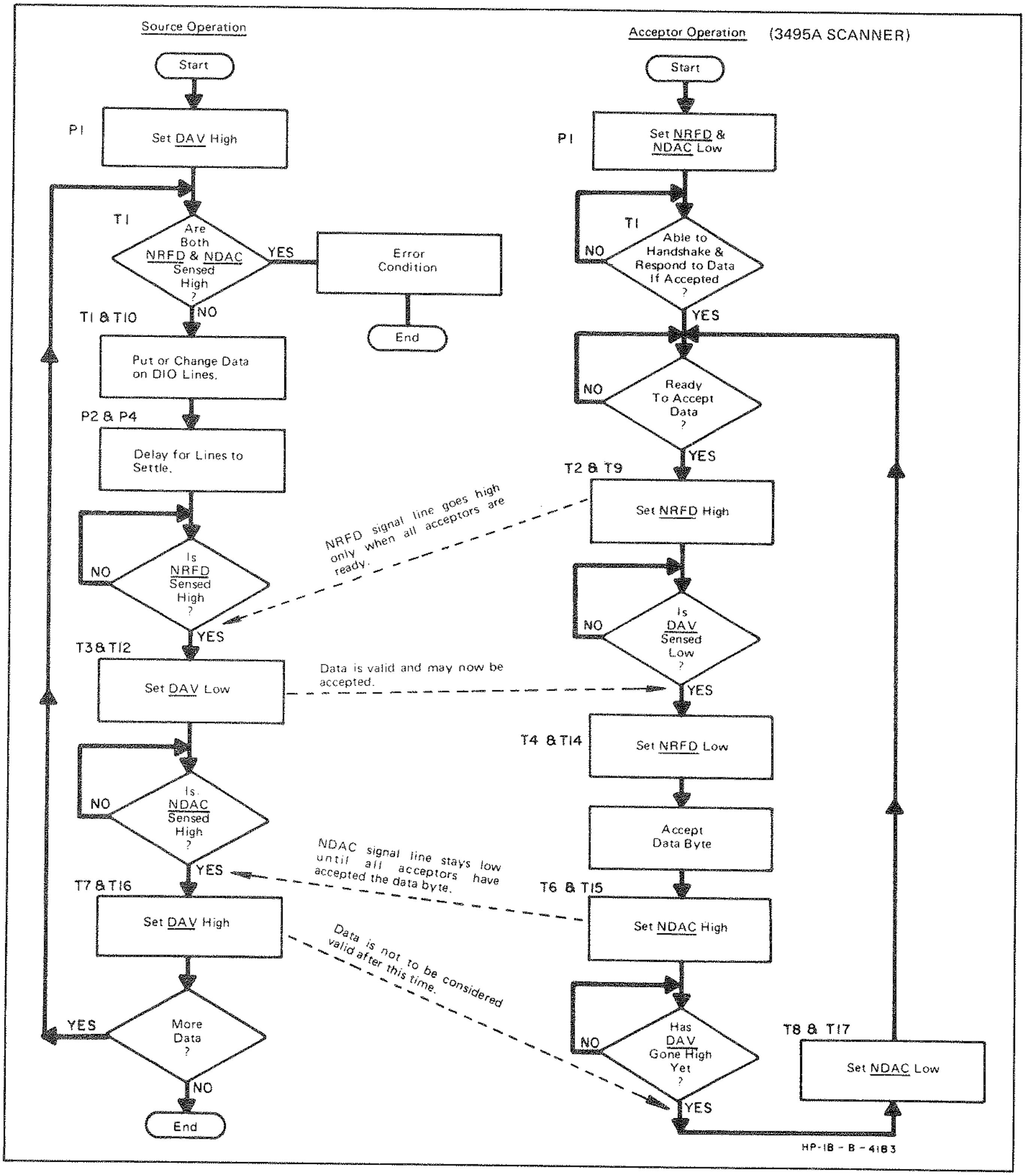


Figure 3-2. HP-IB Handshake Sequence.

3-42. THE HEWLETT–PACKARD INTERFACE BUS (HP–IB).

3-43. The 3495A Scanner receives commands and instructions from the controller over the HP–IB. The HP–IB System uses the ASCII (American Standard Code for Information Interchange) code in bit parallel, character serial form.

NOTE

The HP–IB conforms to the IEEE standard 488-1975 and uses LOW True Logic.

3-44. The HP–IB signal lines used by the 3495A Scanner are listed in Table 3-2. For convenience, each bus signal line is identified by a mnemonic, which is an abbreviation of the signal name.

Table 3-2. HP-IB Signals/3495A Scanner.

Mnemonic	Signal Name
DIO (1-7)	Data Input/Output
ATN	Attention
NRFD	Not Ready for Date
NDAC	Not Data Accepted
DAV	Data Valid
IFC	Interface Clear

3-45. Data Lines (DIO1 – DIO7).

3-46. The 3495A Scanner uses seven of the eight data lines on the HP–IB. All of the lines are LOW True.

3-47. Attention (ATN).

3-48. When ATN is low, the HP–IB is placed in the Command mode, and the controller may place addressing and command information on the data lines. When ATN is High, the HP–IB is placed in the Data mode, and the controller or talker may place device dependent data on the data lines.

3-49. Handshake Signals (NRFD, NDAC, DAV).

3-50. Transfer of information over the HP–IB is managed by a three-wire handshake sequence. The handshake sequence between a talker and a listener (the 3495A) is illustrated in Figure 3-2. The designated Talker and Listener instruments must have the handshake capabilities necessary to implement the sequence. Typical handshake times for 3495A commands and instructions are given in Table 1-2 of Section I.

3-51. Interface Clear (IFC).

3-52. When IFC is set LOW, the HP–IB is cleared and all transfer of information over the Bus halts.

NOTE

The IFC signal does NOT clear the scanner channels. It DOES clear the previously stored instructions.

3-53. Scanner Bus Capabilities.

3-54. The interface capabilities of the -hp- Model 3495A Scanner are listed in Table 3-3.

Table 3-3. 3495A Scanner Bus Capabilities.

Mnemonic	Description of Capability
SHO	No source handshake capability
AH1	Complete acceptor handshake capability: allows the Scanner to take a byte (command or data) from the bus (Listen).
TO	No talker capability
TEO	No extended talker capability
L2	Basic listener capability: allows the Scanner to be selected to listen (Addressed).
LEO	No extended listener capability
SRO	No service request capability
RLO	No remote-local capability
PPO	No parallel poll capability
DC1	Complete device clear capability: allows the Scanner to be cleared (open all channels).
DT1	Complete device trigger capability: permits the Scanner to have its operation initiated by a controller.
E1	Open Collector Drivers

GENERAL HP–IB PROGRAMMING

3-55. The Algorithm.

3-56. An Algorithm is a procedure for obtaining a solution to a problem. Programming HP–IB instruments is made easier by developing an algorithm prior to writing actual programs.

3-57. The procedure for controlling the scanner can be stated as a number of well-defined steps. Once the steps are known, programs for almost any controller can be written.

3-58. Defining the Steps.

3-59. The Scanner's entire set of programmable capabilities can be summarized as follows:

a. **Clear.** Clear (open) all channels (clear instructions sent AND executed).

b. **Close.** Close one or more channels (close instructions sent AND executed).

c. **Trigger.** Execute previously received instructions.

With Option 100

d. **STEP.** Increments or decrements dependent on prior FIRST and LAST channel programming instructions and executes the present channel programming instruction. The channels cycled through, and the increment versus decrement behavior are programmable. The step can be performed by software or an externally applied increment signal.

Therefore, any step in a Scanner algorithm must perform one or more of these four functions.

3-60. Program Example. A program is needed to perform the following:

a. Close only channels 21 and 31.

b. Change to channels 22 and 32 on a later command.

c. Increment through channels 33 to 36.

An algorithm to accomplish this would be:

d. **Clear** the Scanner.

e. **Close** channels 21 and 31.

f. Send to the Scanner the clear instruction, and the close channel 22 and 32 instructions.

g. **Trigger** the Scanner to execute the previous instructions.

h. Increment four times. This can be accomplished by either:

1. Sending four *step* (S) instructions.
2. Sending the external increment on (I1) instruction followed by applying four increment pulses.

3-61. Notice that the algorithm does not say *HOW* to perform each step, just *WHAT* steps are needed. To actually perform each step of a Scanner algorithm, a thorough knowledge of the Scanner's programming mode is needed.

3-62. PROGRAMMING MODEL FOR THE 3495A SCANNER.

3-63. The way the Scanner performs the steps of an algorithm is determined by the Scanner's set of commands and instructions (data). Commands are sent to the Scanner when the HP–IB is in the Command mode (ATN LOW). Instructions are sent to the Scanner when the HP–IB is in the Data mode (ATN HIGH). The Scanner does not use the EOI, SRQ, REN, and DIO8 lines of the HP–IB.

3-64. In the Command mode the 3495A can be addressed to Listen, addressed to unlisten, cleared, or triggered to execute previous data mode instructions. Table 3-4 lists the set of 3495A commands in the command mode.

Table 3-4. Commands.

Command	ASCII	DIO7–DIO1	Decimal	Comments
Selected Device Clear (SDC)	EOT	0000100	4	Scanner Must Be Listening With The HP-IB In The Command Mode.
Group Execute Trigger (GET)	BS	0001000	8	
Device Clear (DCL)	DC4	0010100	20	Scanner Must Be Listening
My Listen Address (MLA)	Table 3-1	Table 3-1	Table 3-1	The HP-IB Must Be In The Command Mode To Address The Scanner.
Unlisten Address (UNL)	?	0111111	63	

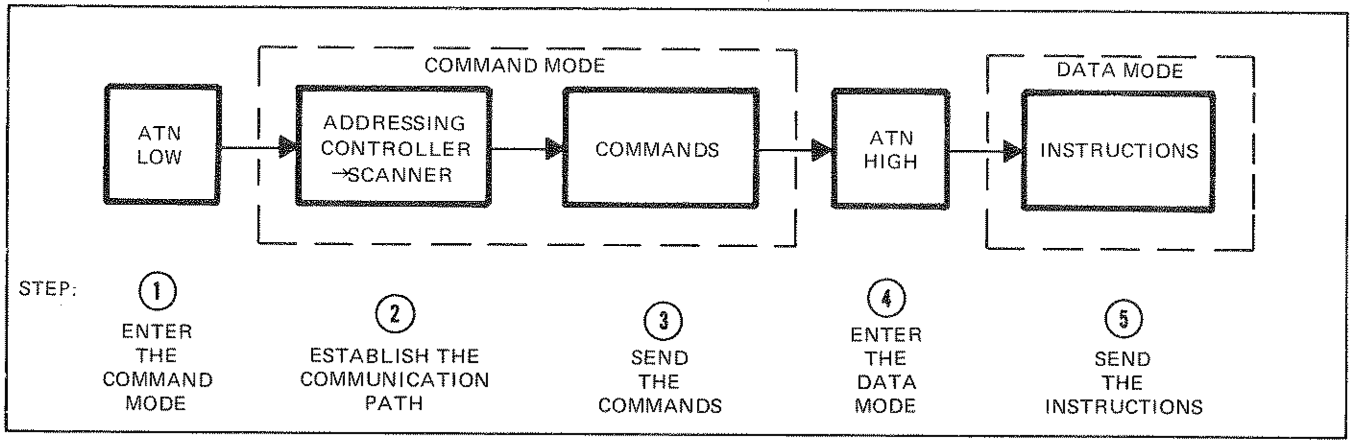


Figure 3-3. 3495A Scanner Programming Model.

3-65. In the Data mode, a *listening* 3495A can be instructed to close and open channels or receive instructions to be triggered in the Command mode. With the A8 fast controller (Option 100), the 3495A can increment or decrement through a selectable block of channels under software or external control. This behavior is programmed by specially handled characters within the 3495A instruction set. Table 3-5 lists the set of 3495A instructions in the Data mode.

3-66. A programming model for the 3495A Scanner is shown in Figure 3-3. Steps in an algorithm are performed by programming the Scanner in compliance with the basic sequence summarized in the model. The basic sequence:

a. Enter the Command mode (ATN LOW).

b. Address controller to Talk; Scanner to Listen (establish the communication path).

NOTE

Sending the unlisten address (ASCII ?) prior to the Talk and Listen address as is advised to eliminate unwanted listeners.

c. Send the commands (Table 3-4).

d. Enter the Data mode (ATN HIGH).

e. Send the instructions (Table 3-5).

3-67. Once the communication path is established, the Scanner will listen until addressed to unlisten. If not addressed to unlisten, Step b may be skipped. If commands are not to be sent, Step c may be skipped. This would be the equivalent of sending a Data message. If the communication path need not be re-established, and no commands are to be sent, Steps a – c may be skipped and Step d performed only once. However, addressing all devices to unlisten prior to Talker and Listener addressing is advised in *every* algorithm step to guarantee the integrity of the communication path.

3-68. HP–IB Command Mode.

3-69. The functions of the 3495A Commands listed in Table 3-4 are described below.

Selected Device Clear (SDC):
Opens all channels if the 3495A is presently addressed to listen (a listening 3495A).

Table 3-5. Instructions.
(Shaded instructions are valid with Option 100 only.)

INSTRUCTION	ASCII CHARACTER	DECIMAL
Digit	Ø,1,2,3,4,5,6,7,8,9	48 thru 57
Space	SP	32
Clear	C	67
Execute	Carriage Return (CR), E	13, 69
External Increment Off	IØ	73, 48
External Increment On	I1	73, 49
First Channel	F	70
Last Channel	L	76
Software Increment	S	83
No Operator	NUL, DEL	0, 127
Delimiter	Any other character	1 thru 126*

*With preceding exceptions

Group Execute Trigger (GET):
Executes all previously unexecuted HP–IB data mode instructions stored in the 3495A if the 3495A is listening.

Device Clear (DCL):
Opens all channels unconditionally.

My Listen Address (MLA):
Addresses the 3495A so that it will listen.

Unlisten Address (UNL):
Addresses the 3495A so that it will not listen.

3-70. HP–IB Data Mode.

3-71. Data mode instructions consist of channel programming instructions and specially handled characters. Table 3-5 lists the 3495A Data mode instructions.

3-72. Channel Programming Instructions.

3-73. Channels are programmed to close and decades or duo-decades to clear with two digit instructions consisting of a ten's channel digit (decade select) and a unit's channel digit (channel select). Instructions accumulate in two-character fields with special restrictions on spaces and delimiters. Accumulated instructions are executed by a Carriage Return (CR), Execute (E), or Software Increment (S), at the end of the instruction string, or by the Group Execute Trigger command in the HP–IB Command mode. Any number of Actuator channels per decade may be closed simultaneously but only one Low Thermal channel per option may be closed.

NOTE

An ASCII Carriage Return is automatically sent by many calculators at the end of an instruction string and must be suppressed if not wanted.

3-74. Specially Handled Characters.

3-75. In addition to the ASCII "CR" and "E" characters, an ASCII "C" in the HP–IB Data mode will immediately open all channels. ASCII "NUL" and "DEL" characters are unconditionally ignored. Spaces act as zeros or are ignored in instruction strings (see instruction formatting). Delimiters serve to begin or end instruction fields.

NOTE

The SDC *and* DCL *commands and the "C" instruction also return the 3495A to the start-up SA and I∅ or I1 mode as determined by switches 6 and 7 on A8S1.*

3-76. Further Special Characters, Option 100.

3-77. The special characters added by the A8 fast controller are used to set bounderies on all increment behavior, to suppress or implement the external implement capability, or to generate a software controlled increment.

3-78. An ASCII "F" preceding a channel number selects that channel as the first channel in the block. An ASCII "L" preceding a channel number selects that channel as the last channel in the block. After initializing F and L, the ASCII characters "F" and "L" can be used in place of the channel numbers.

3-79. If the numerical value of F is less than the numerical value of L, the channels will increment. If the numerical value of F is greater than the numerical value of L, the channels will decrement. Incomplete or illegal values for F or L will not change them from their prior values.

3-80. Channels increment or decrement into the block if the behavior of the incrementation or decrementation is *towards* the block. If the behavior is *away* from the block, the first increment (an ASCII "S" in the data mode or a negative transition at the external increment input at J5 with the external increment software enabled [I1 mode]) jumps to the first channel.

3-81. An ASCII "S" in the data mode immediately increments a channel and executes accumulated instructions in a line. The software increment capability of the A8 interface and control assembly cannot be disabled.

3-82. The external increment capability of the A8 interface and control board is enabled by an ASCII "I1" and disabled by an ASCII "I∅".

3-83. F and L are initialized to 00 and 79 respectively during a power-up condition, after the SDC or DCL commands, or after the "C" instruction. In addition, a power-up condition initializes the external increment capability as determined by dip switch six (6). A closed switch enables the external increment capability upon turn-on. This is the factory set position.

3-84. Instruction Formatting.

3-85. The basic format for a channel-close instruction is:

|←F→|
$T_1 U_1$ $T_2 U_2$ . . $T_n U_n$ E

Where T = Tens channel digit (decade select)
U = Units channel digit (channel select)
E = Execute or Carriage - Return (CR)
F = Instruction field (shaded)

For example, the instruction:

07 35E

Will close channels 07 and 35 (if the decade clear addresses are *not* 0 or 3).

3-86. The following rules govern formatting instructions in ways other than the basic format. In all examples, assume a decade clear address of 6, and that the scanner is listening and in the Data mode. Complete instruction fields are shown as shaded areas. Spaces are shown as a ＿.

a. The second successive leading space (before a digit) in a field acts as a zero. **All others are ignored.**

Example: ＿ ＿ ＿ 7E — Closes Channel 7

1. Trailing spaces (after a ten's channel digit) in a field are ignored.

Example: 7＿ ＿4E — Closes Channel 74

b. A lone digit in a field (creating an incomplete field) acts as a ten's channel digit and execution clears that decade.

Example: 355E — Closes Channel 35 and clears decade 5 (duo-decade 4 with options 004 or 005)

c. Delimiters separate instruction fields.

Example: 4＿ ＿, 5E — Clears decades 4 and 5 (duo-decade 4 with options 004 or 005)

NOTE

Delimiters may be used in instruction strings to enhance program readability.

d. All instructions in a line are executed simultaneously with priority given to the latest instruction.

Example: 2,23 — Insures that only Channel 23 is closed on decade or duo-decade 2.

NOTE

This effects break-before-make sequencing on Actuator decades but is not necessary on Low Thermal decades.

NOTE

This type of format can be used on actuator decades to open **only selected channels.** *For example:*

1, 10 11 12 13 14 15 17 18 E

will open only channels 16 and 19 without even momentarily opening the other channels within this decade.

e. The latest Low Thermal channel instructions supercedes all previous channel instructions in the same decade.

Example: 25 26E — Closes Channels 25 and 26 on an actuator decade but only Channel 26 on a low thermal decade or duo-decade.

f. The "Clear" instruction ("C") immediately opens all channels. An "Execute" ("E") instruction is not needed.

Example: 24C — Opens all channels.
C24E — Insures that only Channel 24 is closed.

g. "No operator" instructions are always ignored.

h. F and L require complete instruction fields following the "F" and "L" special characters. An execute "E" instruction is not needed.

Example:

F21 L32 — Defines a block of channels with a first channel of 21 and a last channel of 32.

FØE L2ØE — F is not affected.
L is defined to 2Ø.
Duo-decade Ø is cleared (opens).
Channel 2Ø is closed.

i. If F < L. . .the 3495A increments through the channels. If F > L. . .the 3495A decrements through the channels.

j. FE and LE output the current first and last channels respectively. This does NOT change the current value of F or L.

k. IØ = External Increment Off. I1 = External Increment On.

l. An "S" (Software Increment) is immediately executed and is not affected by the IØ or I1 instructions.

m. The first "S" special character acts as an execute to accumulated instructions.

Example:

22 SS — Closes channel 22 and increments or decrements ONCE.

n. The first increment/decrement jumps the 3495A to the current first channel if headed away from the first channel. Otherwise the 3495A will increment/decrement to it.

Example:

F30 L35 40E — The first "S" jumps to channel 30.

F30 L35 20E — Increments from 20 into the defined block, upon increment signals.

Table 3-6. Implementing The Algorithm Example.

Algorithm Step	Necessary Model Steps	Commands (Step 3)		Instructions (Step 5)	Comments
		ASCII	Command		
Clear the Scanner	1→2→3	DC4 OR EOT	DCL OR SDC		The addressing in Step 2 is not necessary for the DCL command but is needed in subsequent algorithm steps.
Close Channels 21 and 31	1→2→4→5			2131E	Steps 1 and 2 are not necessary but are advised to insure that only *wanted* talkers and listeners are on the bus.
Send the Scanner the Clear instruction, and the Close Channel 22 and 32 instructions.	1→2→4→5			C2232	Steps 1, 2 and 4 may be omitted as described above. An end-of-line carriage return must be suppressed to prevent immediate execution.
Trigger the Scanner to execute the previous instructions	1→2→3	BS	GET		Step 2 may be omitted as described above.
Increment four times	1→2→4→5			SSSS	
Complete Program Sequence Advised: 1→2→3→1→2 →4→5 →1→2→4→5→1→2→3 →1→2→4→5 Minimum: 1→2→3→4→5→5→1→3 →4→5					

The shaded step(s) require(s) the A8 Interface and Control Assembly.

3-87. Refer to the algorithm developed for the program example at the beginning of General HP–IB Programming. The basic programming steps needed to perform each step of the algorithm can be determined from the scanner programming model in Figure 3-3. The commands used in Step 3 of the Model and the instructions used in Step 5 have fixed ASCII values. With information on instruction formatting, the actual instructions can be determined.

3-88. Table 3-6 uses the Scanner programming Model to develop the programming steps, commands, and instructions needed to implement the algorithm example.

3-89. To write the final program, you must know the specific controller language. Even without knowing the controller language, you *can* develop an algorithm and determine what program steps, commands, and instructions are needed to implement your algorithm. Once this is done, translating the steps into specific controller statements is easier.

3-90. PROGRAMMING CONSIDERATIONS: Option 100.

3-91. Take care to avoid or suppress unwanted end of line carriage returns when defining first and last channels in a block.

NOTE

The most recent first or last channel programming instruction is retained by the fast controller assembly. Programming the first channel **after** *the last channel will ensure first channel closure upon the first increment signal. See instruction formatting rule "m".*

APPLICATIONS

3-92. INTRODUCTION.

3-93. This sub-section contains information on a few of the many applications of the -hp- Model 3495A Scanner. Information on programming the 3495A with -hp- calculators can be found as appendices to this manual. As additional -hp- controllers are introduced, operating notes containing programming information for the 3495A will become available and should be included in the support documentation summary at the end of Section I.

3-94. The General HP–IB Programming Sub-Section describes the 3495A commands and instructions and develops a programming model for use in translating specific controller languages to functional scanner control messages.

3-95. Low Thermal Applications (Option 001).

3-96. Low Thermal channels are typically used for voltage scanning, 2 wire ohms scanning, and 4 wire ohms scanning. Figure 3-4 illustrates the basic hookup for voltage scanning. Figure 3-5 is a physical diagram of terminal connections for voltage scanning with an -hp- Model 3490A Digital Multimeter. Figure 3-6 is a functional view of this application.

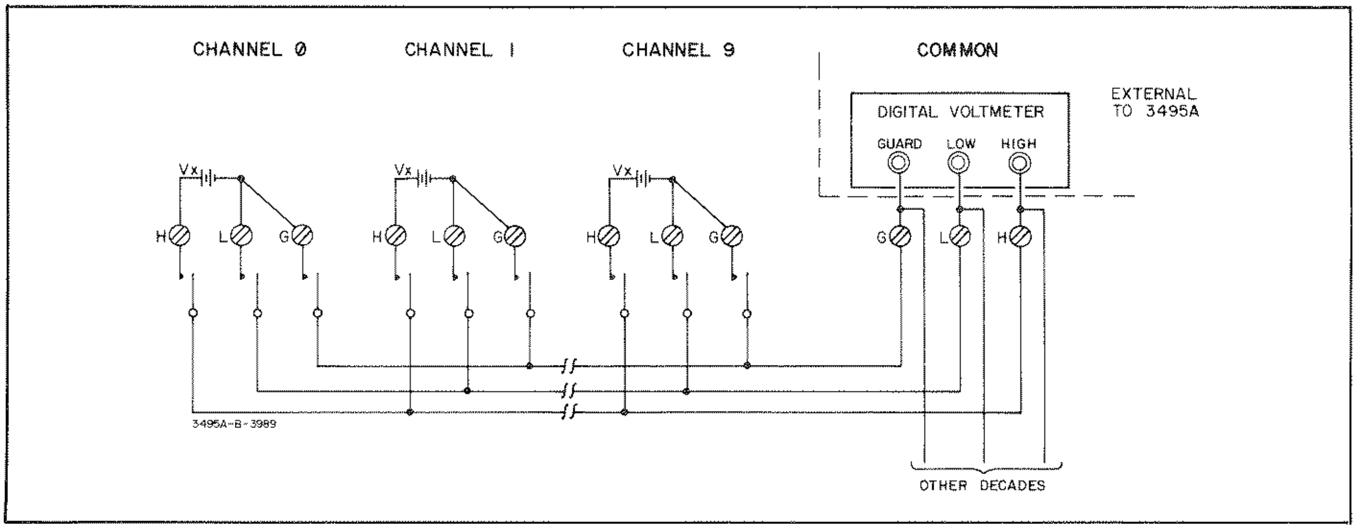


Figure 3-4. Basic Volts Multiplex Scanning (Low Thermal) (Option 001).

3-97. A physical view of two-wire ohms scanning with a 3490A Digital Multimeter is illustrated in Figure 3-7. A functional view of this application is shown in Figure 3-8.

3-98. A physical view of four-wire ohms scanning with a 3490A Digital Multimeter is illustrated in Figure 3-9. A functional view of this application is shown in Figure 3-10.

3-99. Guard terminals are provided for each channel. If a Guard-to-Low connection is not made at the point of measurement a guard Common-to-Low Common connection is needed on the terminal assembly.

3-100. Actuator Decade Applications (Option 002).

3-101. Actuator decade channels are typically used for voltage scanning and matrix scanning applications.

3-102. A physical view of the terminal connections for voltage scanning with a 3490A Digital Multimeter is shown in Figure 3-11. A functional view of this application is shown in Figure 3-12.

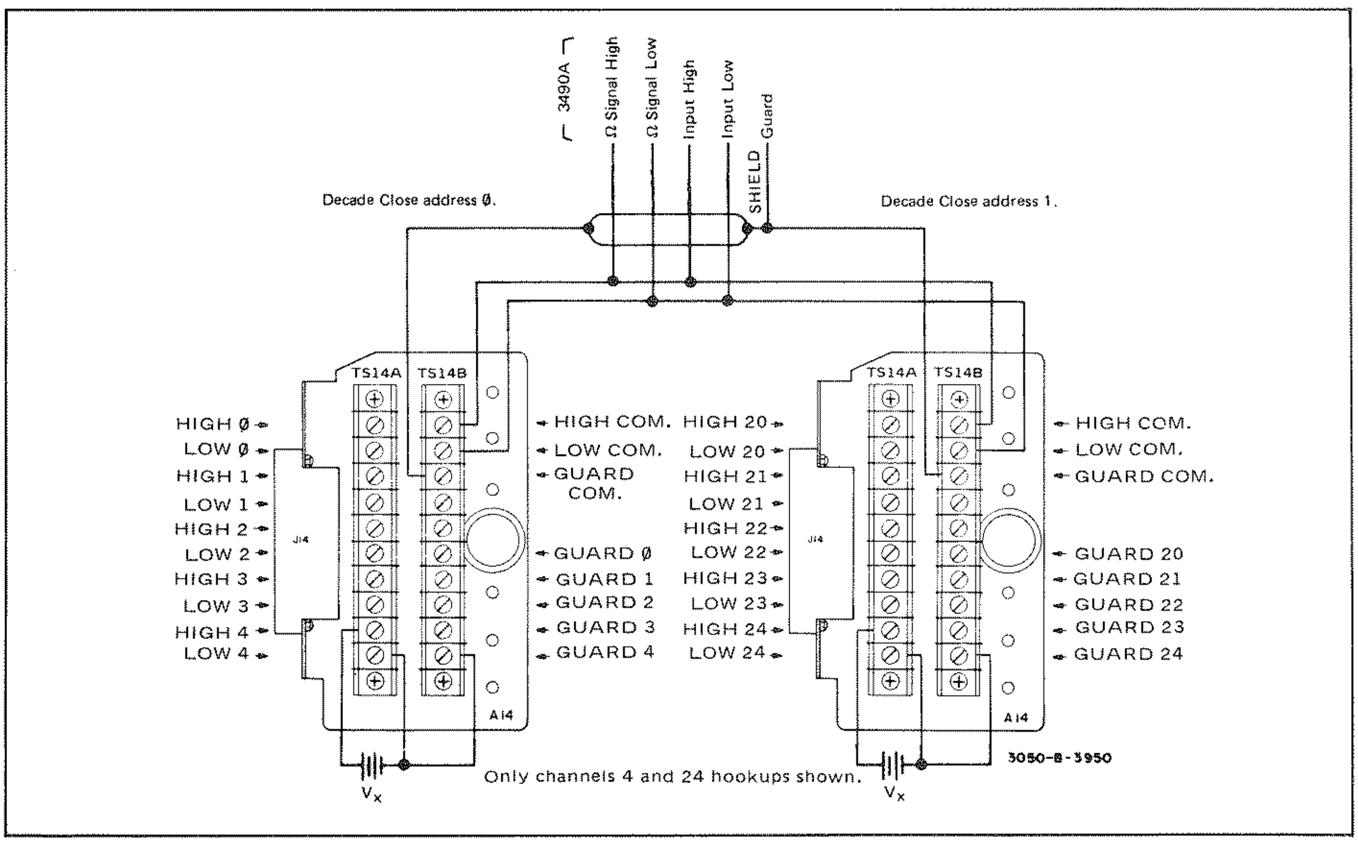


Figure 3-5. Physical View: Voltage Scanning (Option 001).

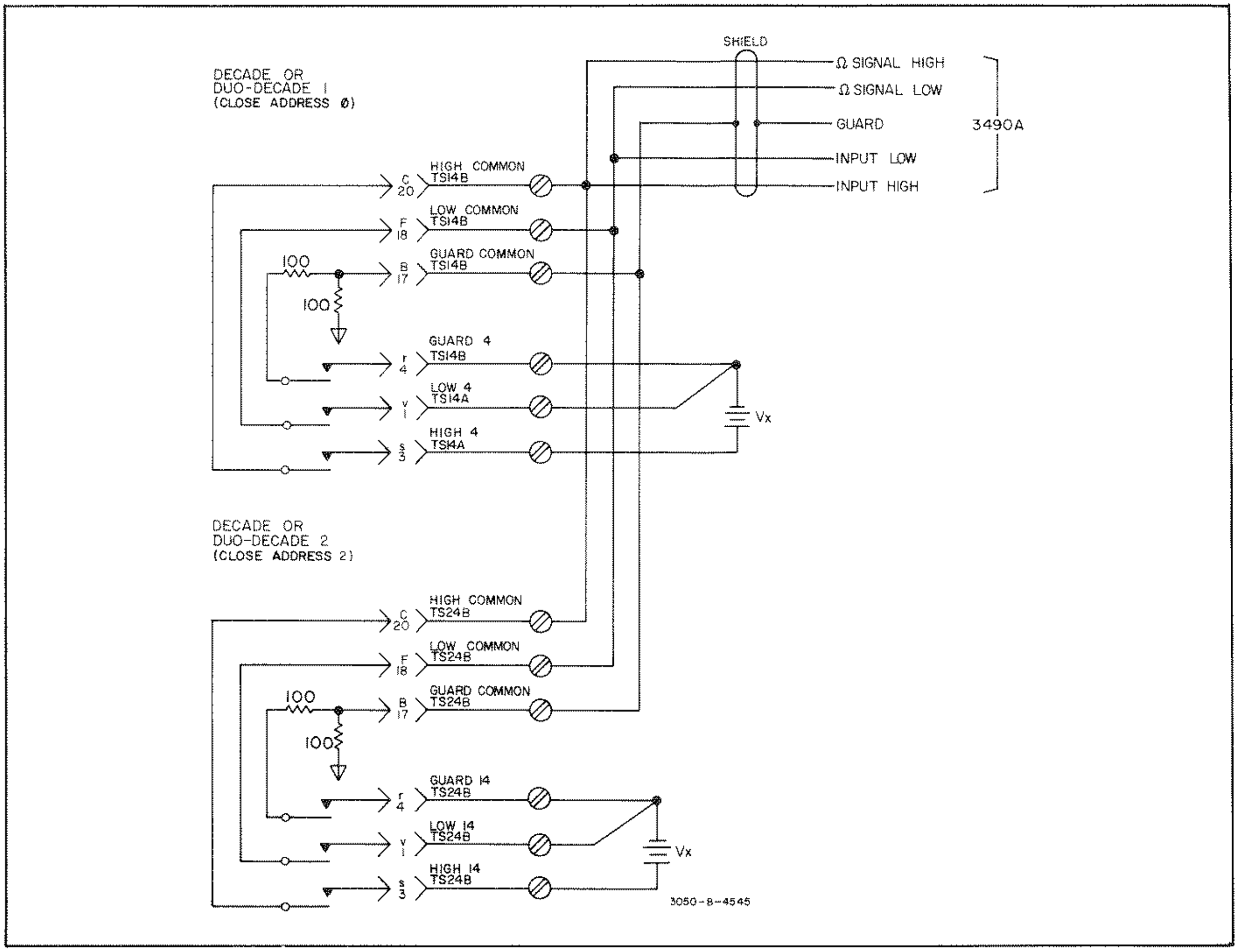


Figure 3-6. Functional Diagram for Voltage Scanning (Options 001 and 004).

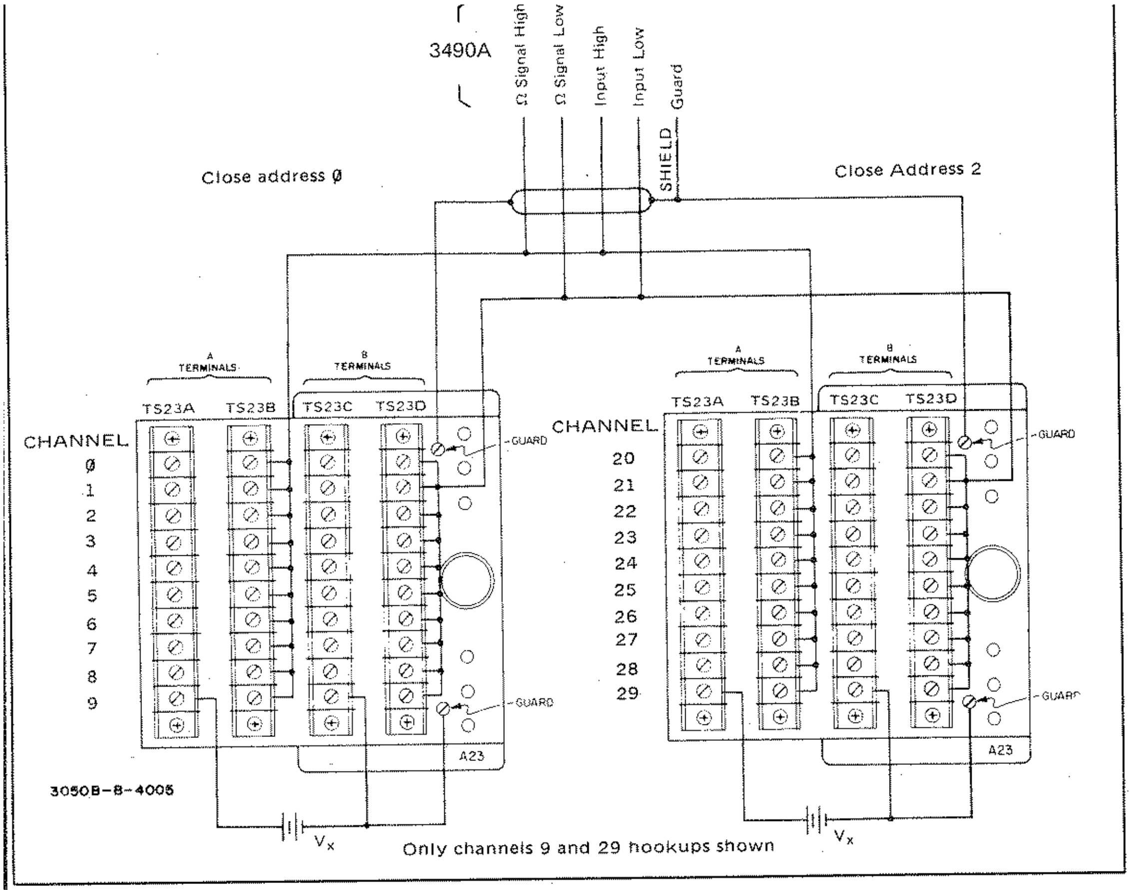


Figure 3-11. Physical View: Voltage Scanning (Actuator).

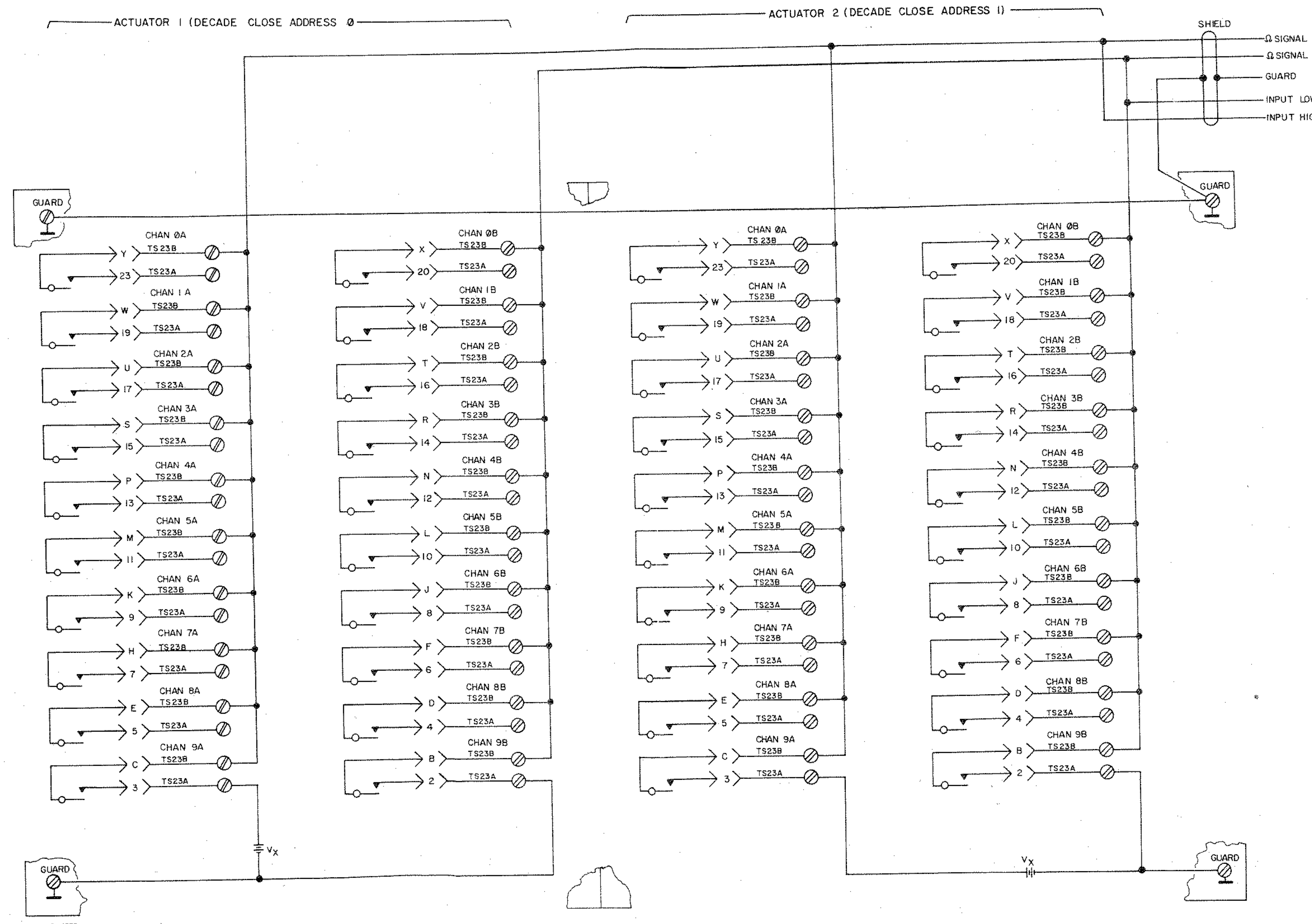


Figure 3-12. Functional Diagram of Voltage Scanning (Option 002).

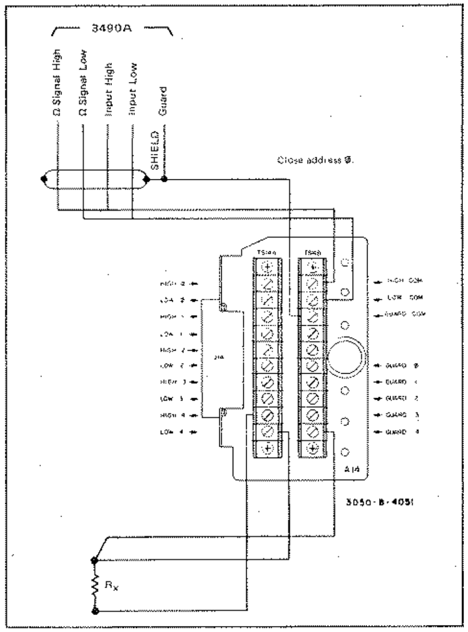


Figure 3-7. Physical View: 2 Wire Ohms Scanning (Option 001).

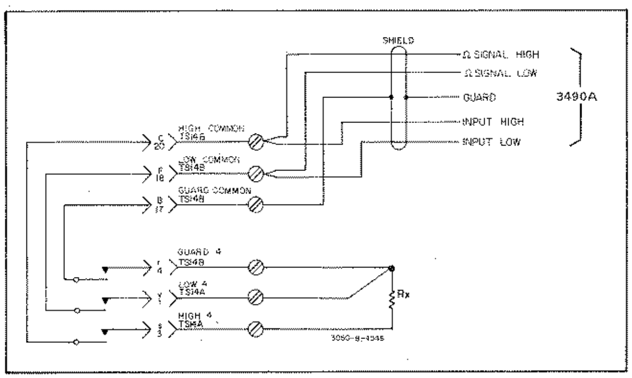


Figure 3-8. Functional Diagram for 2 Wire Ohms Scanning (Options 001 and 004).

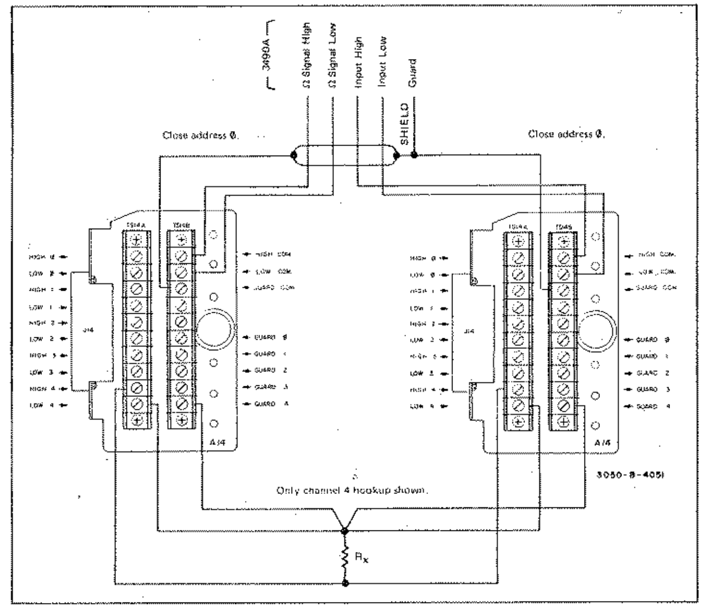


Figure 3-9. Physical View: 4 Wire Ohms Scanning (Option 001).

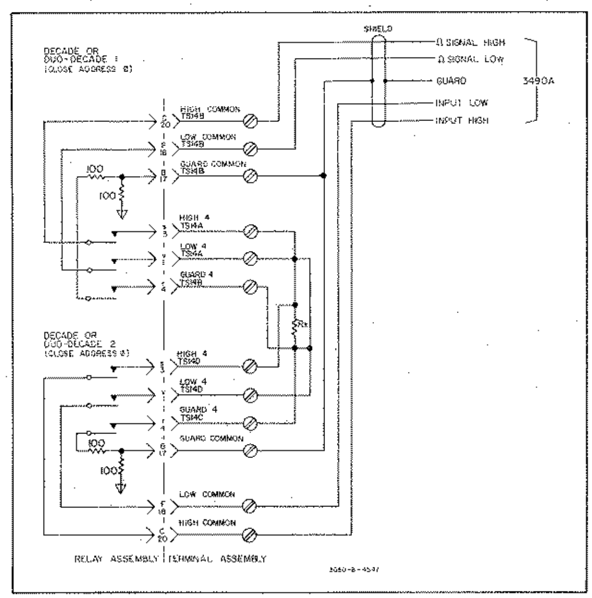


Figure 3-10. Functional Diagram for 4 Wire Ohms Scanning (Low Thermal).

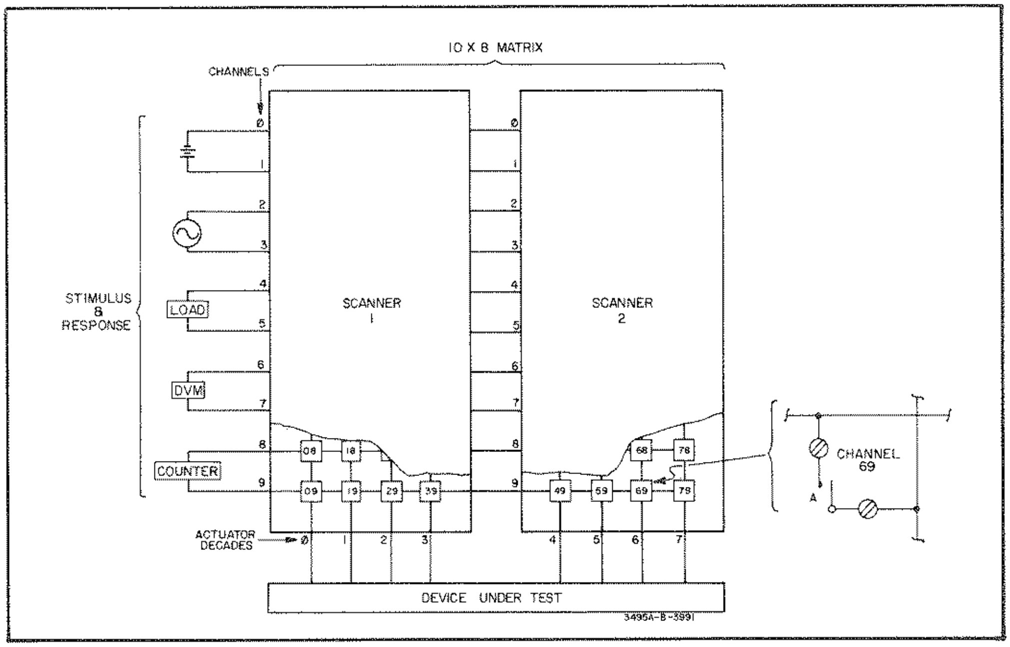


Figure 3-13. Matrix Scanning.

3-103. Figure 3-13 demonstrates how Actuator channels may be connected in a matrix arrangement for connecting stimulus and response instruments to the pins of a device under test. Any instrument may be connected across any two pins of the device and any number of the instruments may be connected simultaneously. Both scanners are given the same HP–IB Listen address and the eight decade Logic assemblies are each given one unique Close address. The channels must be closed in pairs; for instance, channels 9 and 18 connect the counter to the first two pins of the device. Matrix scanning permits multiple measurements to be made simultaneously.

3-104. Two Guard terminals are provided on each actuator decade terminal assembly. Guarding principles are discussed later in this section.

3-105. THERMOCOUPLE APPLICATIONS (Options 003 and 005).

3-106. The -hp- Model 3495A Scanner can be used to channel temperature information to other instruments. This feature is available as Option 003 (decade option) or as Option 005 (duo-decade option). The substitution of a Thermocouple Reference Connector for the terminal assembly used in low-thermal ohms or voltage scanning makes this possible.

3-107. INTRODUCTION.

3-108. The thermocouple decade and duo-decade options are options 003 and 005 respectively for the Model 3495A Scanner. In these options a thermocouple reference connector replaces the low thermal terminal assembly of options 001 and 004. Installation procedures for all 3495A options are in Section II, Installation.

3-109. The substitution of the thermocouple reference connector in these options provides the 3495A Scanner with the capability of making thermocouple temperature measurement without the use of a separate reference junction. The following paragraphs review thermocouple fundamentals and describe the operation of the connector as an integral part of a temperature measuring system. For further information on the thermocouple theory and temperature measurements, a list of references is provided at the end of this section.

3-110. Thermocouples in Temperature Measurements.

3-111. Thermocouples are temperature-to-voltage transducers which are used extensively in temperature measuring instruments. By connecting two wires made of different metals, a voltage is developed across the connection. This voltage is called the Seebeck or thermal voltage and depends on the composition of the two metals and the temperature of the measuring junction. To measure the Seebeck voltage, a thermocouple circuit is formed as in Figure 3-14, creating a new junction called the reference junction.

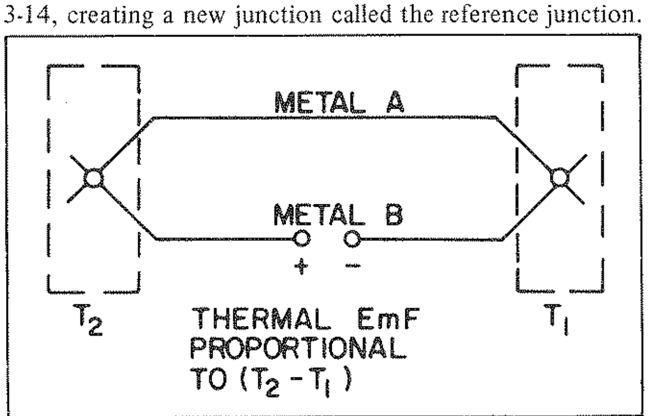


Figure 3-14. Thermocouple Circuit.

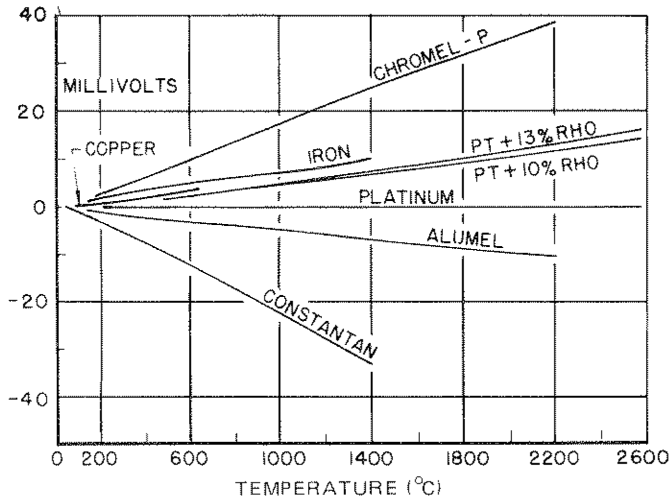


Figure 3-15. V vs. T for Common Thermocouple Materials.

The open circuit voltage of this circuit is dependent on the composition of the two metals and the difference in temperature between the two junctions. A graph of the voltage-to-temperature characteristics of commonly used metals is shown in Figure 3-22. Note that these characteristics are referenced to platinum.

3-112. The thermocouple materials are chosen such that a temperature difference ($T_2 - T_1$) develops series aiding thermal emf's, which appear as the open circuit voltage. If the elements consist of the same metals, the thermal emf's are equal and opposite in polarity, resulting in zero open circuit voltage regardless of the difference in temperature. In the case of T_2 and T_1 being equal, zero open circuit voltage results regardless of what thermocouple materials are used. The National Bureau of Standards has developed accurate mathematical means for describing the voltage-to-temperature relationships, expressed as polynomial expansions or sets of tables, can be used to accurately transfer thermocouple voltage measurements into temperature measurements. For more detailed information on thermoelement and thermocouple modeling, see Reference 4.

3-113. If the temperature of one thermocouple junction is held constant, the open circuit voltage is dependent on the temperature of the other junction. In this way the temperature of one junction can be used as a reference to which the temperature of the measuring junction can be compared. The most commonly used reference junction temperature is 0°C. This is also the reference temperature for the NBS tables. It would therefore seem that temperature measurements based on NBS type thermocouple information need be referenced to 0°C. This method requires strict physical or electrical control of the reference junction temperature. Deviations in this reference temperature from 0°C would create corresponding temperature measurement errors. By electrically or mathematically correcting for reference temperature variations from 0°C, the reference temperature could take on any ambient value, with no resultant measurement error. This is the method used in the Hewlett-Packard Thermocouple reference connectors.

3-114. THE REFERENCE CONNECTORS (A24 and A46).

3-115. Functional Description.

3-116. The thermocouple reference connectors provide a means of accurately measuring the enclosure temperature. This allows mathematical compensation for the arbitrary but known reference temperature and eliminates the inconvenience and expense of an actual 0°C reference temperature. A functional view of the reference connectors is shown in Figure 3-16. A temperature monitoring thermistor is tied to Channel Ø of the reference connectors, leaving the remaining channels free for thermocouple connections. The temperature monitoring and corrective procedure is as follows:

a. Thermistor resistance is measured, R.

NOTE

Sample R! continuous ohms monitoring can cause thermistor self-heating! Select an ohmmeter range which uses .7 mA or less, depending on your resolution requirements (Exp: -hp- 3455A in the 10 kilohm range). A .1 mA ohmmeter current is advised if possible (Exp: -hp- 3455A in 100 kilohm range; high resolution to retrieve resolution.)

b. Reference Temperature is computed, T_R:

$$T_R = \frac{5041.6}{\text{Ln}(R) + 7.15} - 314.052 \quad \text{Equation 1}$$

c. Thermocouple compensation voltage V_R is calculated for each thermocouple type used at the appropriate reference temperature T_R. This is a software process to compensate for the thermal emf generated by the *reference* junction temperature. Remember, the result desired is the *measuring* junction temperature.

d. Thermocouple voltage is measured, V_S.

e. Correction is made by adding compensation voltage to thermocouple voltage:

$$V_R + V_S = V_T$$

NOTE

V_R is negative if $T_R > 0°C$.

f. Measurement junction temperature determined from corresponding V_T.

By adding the appropriate compensation voltage, the NBS thermocouple values may be used with any arbitrary reference temperature. Since the correction is made mathematically the reference connector can be used for any thermo-

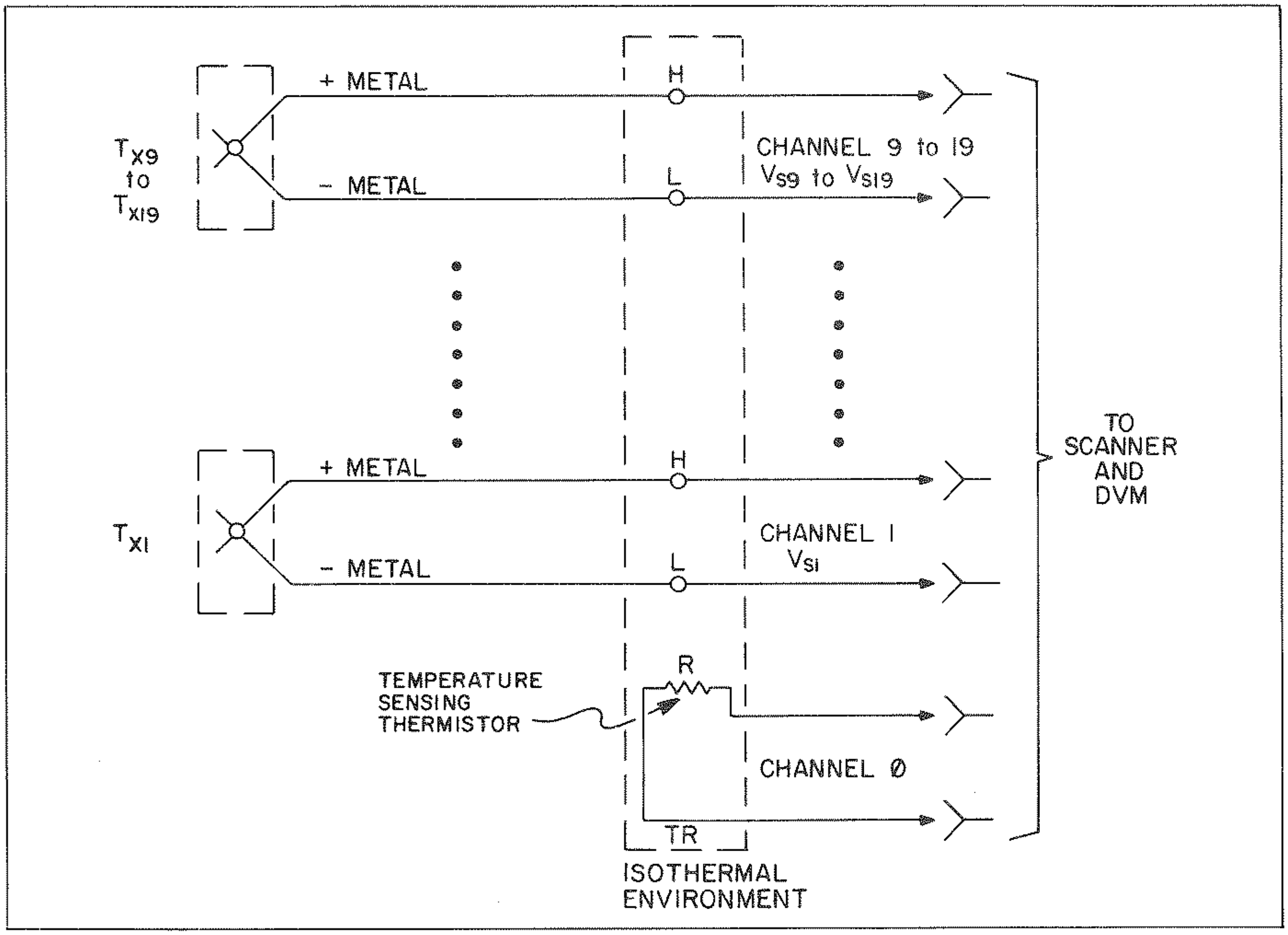


Figure 3-16. The Reference Connectors: A Functional View.

couple type or mixture of types. A table or mathematical model of specific thermocouple characteristics provides data for Steps c and f of the corrective procedure.

3-117. PHYSICAL DESCRIPTION.

3-118. The reference connectors are constructed to minimize temperature differences between the HI and LOW input terminals and the temperature sensing thermistor. A metal shield encloses the assemblies and forms a baffle which limits temperature variations due to convection while providing an entry point and strain relief for thermocouple wires. The temperature difference between channels is also minimized. Option 003 connectors employ an isothermal enclosure to minimize the temperature gradient, while option 005 connectors employ PC cladding. Guard connections are provided for all inputs to improve common-mode rejection in floating measurement configurations. Two sets of HIGH, LOW, and GUARD common terminals are also available on the connectors.

3-119. SOURCES OF ERROR (ACCURACY).

3-120. The accuracy of the Scanner is dependent on the environment it is placed in. A static (steady-state) environment occurs exclusively where the ambient and thus the scanner temperature varies no more than 1°C/hr. A dynamic environment occurs where temperature varies no more than ± 5°C/hr. A 1°C to 5°C change in scanner temperature could occur when moving the scanner from a hot automobile trunk to a ventilated office. A 5°C/hour change in scanner temperature could occur when the heating system is turned on for a work day in an office building. If both occur simultaneously, stated accuracies will *not* apply. If either condition is exceeded the specifications will not apply until after the scanner has equalized with its environment. The thermal time constant of the -hp- Model 3495A Scanner is approximately three (3) hours.

3-121. The possible sources of error which could influence the accuracy of temperature measurements made with the thermocouple reference connector can be characterized as either reference temperature errors or thermocouple measurement errors. Many of these errors are quite dependent on a user's particular system. Table 3-17 summarizes the

$$\text{TOTAL ERROR} = \frac{S_r\,(\Sigma \text{ Ref Temp Errors})}{S_m} + \frac{\Sigma \text{ Meas Voltage Errors}}{S_m} + \Sigma \text{ Temp Errors} \qquad \text{Equation 2}$$

Where S_r = Seebeck coefficient at reference: Type J Thermocouple
and S_m = Seebeck coefficient at measurement: Type J Thermocouple

Table 3-7. Sources of Error (Example: Options 003 & 005).

Reference Temperature Errors	Errors	Measurement Errors	Errors
Thermistor Accuracy (Includes .01°C Thermistor curve fit error)	±.2 °C	Scanner Offset Voltage (3495A) Static Dynamic	±1 μV ±2 μV
Temperature Gradients Along Terminals Static Dynamic	±.1°C ±.3°C	Voltmeter Accuracy (3455A)	±11 μV
Thermocouple Table Conformity	±.01°C	Thermocouple Table Conformity	±.1°C
Ohmmeter Accuracy (3455A)	±.08°C	Thermocouple Calibration	....

possible errors in a representative system. These figures are for an -hp- Model 3051A Data Logger System, using 1 year specifications for the -hp- 3455A Digital Voltmeter, and assuming Type J thermocouples at a 600°C measuring junction temperature. Equation 2 is used to determine the total measurement error (less calibration error) from the errors listed in Table 3-17.

3-122. The thermistor accuracy and temperature gradient errors are inherent to the reference connectors. The thermocouple table conformity error is system dependent. This error occurs when translating the reference temperature to a correction voltage via the NBS tables. The ohmmeter accuracy error is determined from 3455A 1 year specifications. The net temperature error due to ohmmeter inaccuracy may be determined by dividing the maximum error in the thermistor resistance measurement by the worst case thermal sensitivity of the thermistor. Assuming a 2 ohm relay contact error, the net temperature error due to ohmmeter inaccuracy is .066°C. To be safe, .08°C is used.

3-123. A maximum dynamic scanner offset voltage of 2 microvolts is possible with the Model 3495A Scanner and should be included in the calculation. Another slight measurement error is possible when measuring thermocouple voltage. This system dependent error may be determined from DVM specifications. With the Model 3455A DVM, using Type J thermocouples at a 600°C measuring junction temperature, an 11 microvolt error is possible. When transferring these voltage readings into temperatures, an additional .1°C temperature measurement error is possible.

3-124. By using Equation 2, the overall possible measurement error can be calculated. In this example, an overall error of .83°C results. Any user calibration errors would be added to this figure.

NOTE

This representative error applies to both options 003 and 005, within their stated dynamic environment conditions.

3-125. WIRING CONCERNS.

3-126. Care should be taken when connecting thermocouple wires to the reference connector terminals. Bare wire lengths should be kept to a minimum to avoid shorting input connections. The reference connector attaches to the low thermal channel assembly. Check to be sure that the low-thermal assembly is securely in its slot on the scanner chassis. To limit heat transfer along wires, use 18 AWG wires or thinner. The specifications are also a function of this restruction.

3-127. GUARD CONCEPTS.

3-128. Proper system operation when taking measurements with the system DVM's can only be obtained when the DVM's are guarded correctly. A guarded instrument has an additional shield (termed the guard) between the low and ground, effectively increasing the low to ground leakage impedance. With the guard properly connected, it shunts common mode currents away from the source resistances. This current shunt then can virtually eliminate common mode current errors in the instrument measurement. This principle is illustrated for the 3495A in Figure 3-18. For more information on guarding, refer to -hp- Application Note 123, "Floating Measurements and Guarding".

3-129. GUARDING IN TEMPERATURE MEASUREMENTS.

3-130. The thermocouple terminal connectors provide guard terminals for all sets of HI and LOW thermocouple connections. The point at which guard connections are made is dependent on the type of thermocouple used. In general, there are 3 commonly used thermocouple structures, classified by the type of measuring junction as shown in Figure 3-17.

3-131. Exposed Junction Thermocouples.

3-132. Exposed junction thermocouples are typically used

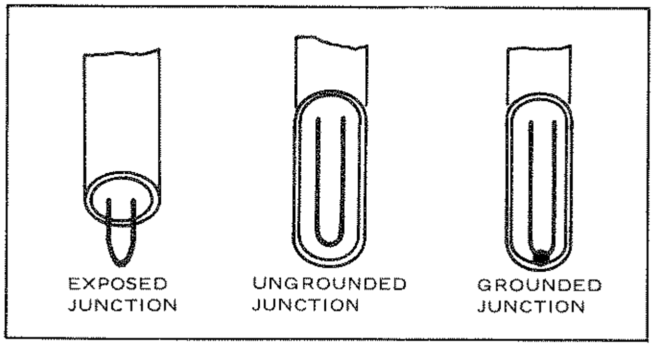


Figure 3-17. Common Thermocouple Structures.

for the measurement of static or flowing non-corrosive gas temperatures where short response times are desired. The junction extends beyond an end-sealed sheath.

3-133. With exposed junction thermocouples guard connections should be made close to the measuring junction on individual sheaths if a relatively low impedance path is suspected between the low thermocouple element and source ground (see Figure 3-18A). If no such path exists, a low-to-guard connection at the connector is adeaute (see Figure 3-18B).

3-134. Ungrounded Junction Thermocouples.

3-135. Ungrounded junction thermocouples are typically used for the measurement of static or flowing corrosive gas and liquid temperatures. The thermocouple wire is physically located from the sheath by a ceramic insulator.

3-136. A guard-to-low connection should be made at the connector to guard ungrounded junction channels. Use 18 AWG or thinner wire to reduce thermal offsets.

3-137. Grounded Junction Thermocouples.

3-138. The grounded junction thermocouple is typically used for the measurement of static or flowing corrosive gas and liquid temperatures and for high pressure applications. The junction is physically attached to the sheath to provide faster response than the ungrounded type.

3-139. With grounded junction thermocouples, guard connections should be made on individual sheaths at the point of measurement if possible. Otherwise, make channel guard to low connections. Use 18 AWG or thinner wire to reduce thermal offsets.

NOTE

Use solid wire when connecting thermocouples and guard connections. This reduces the effects of thermal offsets due to inherent stranded wire qualities.

NOTE

Electrical isolation from the measurement point is advised to eliminate unwanted signals from the thermocouple circuit. A thermal compound may be used to attach the thermocouples to the point of measurement.

3-140. HIGH–SPEED BURST MEASUREMENTS.

3-141. Burst measurements at speeds up to 1000 channels per second is achieved with the fast controller option (Option 100) and the duo-decade channel options (Options 004 and 005).

3-142. The equipment required for this application includes an HP–IB compatible controller and a programmable DVM with a reading rate in excess of 1000 channels per second.

3-143. Figure 3-19 illustrates how an -hp- Model 3495A Scanner can be connected to an -hp- Model 9825A Calculator and -hp- Model 3437A Digital Voltmeter to form a burst measurement system. A sample 9825A program is given to cycle through one duo-decade block of channels, taking and storing the voltage measurements into a high speed buffer.

3-144. The sample burst measurement program in Figure 3-20 uses a high speed input/output calculator buffer to store ASCII data from the 3437A DVM. The high speed buffer is needed when readings are desired at less than 4 millisecond intervals. The 7001 byte length is needed to store the 7 ASCII bytes per reading plus the end-of-burst line feed character.

NOTE

The calculator will generate an E5 error message without this extra byte.

3-145. The entire burst is transferred to the buffer by the trf (transfer) statement. The free-field formatted red (read) statement converts the 7 byte ASCII values to single byte readings in a for-next loop. From this point on, the readings may be manipulated in accordance with your needs and application (statistical analysis, characterization, etc.).

3-146. SWITCHING GUIDELINES.

3-147. Here are a few guidelines to help you maximize the performance and lifetime of your scanner channels:

a. The current that can safely be interrupted by a pair of contacts varies inversely as the product of switching speed and impressed voltage.

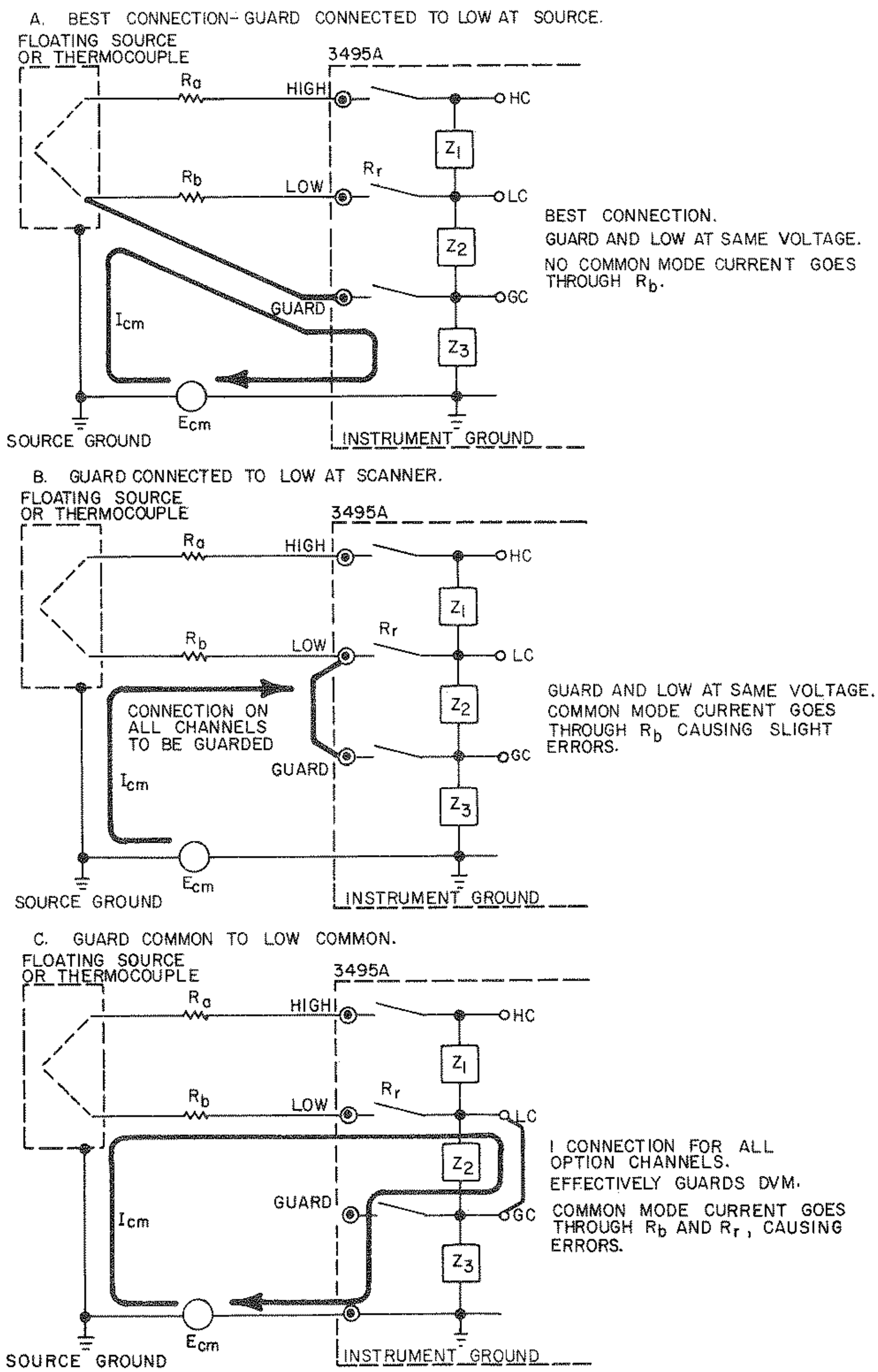


Figure 3-18. Connecting the Guard.

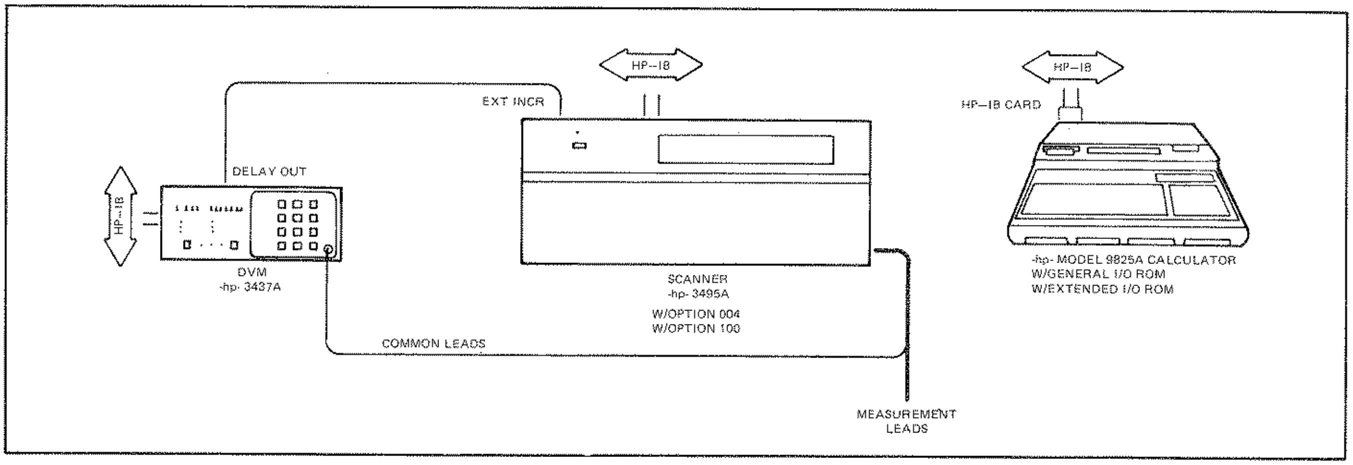


Figure 3-19. Burst Measurement System.

b. The amount of ac current that can be safely interrupted is approximately 1½ to 2 times the amount of dc current that can be safely interrupted, assuming equivalent products as per Step a.

c. For dc switching, higher capacitance causes larger surge currents during closing; higher inductance causes larger voltages during opening.

d. As channel reeds approach the end of their life, the high-to-low contact resistance (shorted inputs) begins to vary, a standard deviation of greater than 0.3 to 0.5 ohms is indicative of approaching end of life.

3-148. Further information on switching concepts can be found in reference 5.

```
0: "START":
1: dim A[1000]
2: "Set up high-
 speed buffer;
 7001 bytes=1000
  readings":
3: buf "BUFFER",
 7001,3
4: "Set up 3495A
  First & Last
 channels & Exte
 rnal Increment
 capability":
5: wrt 709,"L39F
 20I1"
6: "Program 3437
 A DVM":
7: wtb 724,"R3F1
 N1000SD.001ST1"
8: "Transfer
 entire burst
 into BUFFER":
9: tfr 724,"BUFF
 ER"
10: "Wait for
 BUFFER status
 to indicate
 that the data
 transfer is
 complete":
11: if rds("BUFF
 ER")<0;gto +0
12: "Read the
 1000 values
 into variable
 A[I]":
13: fmt 1
14: for I=1 to
 1000
15: red "BUFFER.
 1",A[I]
16: next I
17: wrt 724,"T3"
18: "A[I] can
 now be manipula
 ted as per your
  application.":
19: "END":end
*32653
```

Figure 3-20. Sample Burst Measurement Program.

REFERENCES

1. American Society for Testing and Materials, **Manual On The Use of Thermocouples In Temperature Measurements, (1974).**

2. Moffat, Robert J., **The Gradient Approach to Thermocouple Circuitry, (1961).**

3. Moffat, Rober J., **Thermocouple Theory and Practice, (1961).**

4. Power, Robert L., **NBS Monograph 125: Thermocouple Reference Tables Based on The IPTS–68, (1974).**

5. Holm, Ragnar, **Electric Contacts: Theory And Applications**, (1967).

Table 4-1. Recommended Test Equipment.

-hp- Model No.	Test Code	Required Capabilities	Instrument
9825A	S	HP–IB controller capability* High speed I/O ⩾switching time of option	Calculator
98034A	S		HP–IB Card + Cable
3437A	S	[1]Reading rate ⩾25/sec [2]Reading rate ⩾100/sec [3]Reading rate ⩾1000/sec	DC Digital Voltmeter
6217A	S	20 V dc adjustable	DC Supply
4329A	I	10^{10} ohm range (options 001 & 003) 10^{7} ohm range (others)	High Resistance Meter
4271B	C	2 pF resolution at 1 MHz .1% accuracy	R,L,C, Meter
16032A	C		Test Lead Accessory for R,L,C, Meter
3455A	F	.1 mV ac resolution at 1 MHz	Digital Multimeter
652A	F	3 V rms output frequency to 1 MHz	Test Oscillator
10631	S		HP–IB Cable
11170A	F		BNC-to-BNC Cable
11048C	F		50 ohm termination
1251-2277	F		BNC-to-Dual Banana Plug Adapter
0757-0280 (10-20)	S	1 K ± 1%, 1/8 watt	(10-20) Resistors
3101-1235	S,I	DPDT	(2) Switch(es)

TEST CODES
S – Switching Time
T – Thermal Offset Voltage
I – Channel Isolation
C – Capacitance
F – Frequency Response

*Referenced to IEEE Standard 488-1975
[1]Option 002 with Option 100/Accessory 44413A
[2]Options 001 or 003 with Option 100/Accessory 44413A
[3]Options 004 or 005 with Option 100/Accessory 44413A

SECTION IV
PERFORMANCE TESTS

4-1. INTRODUCTION.

4-2. This section contains performance test procedures that can be used to verify that the 3495A meets specifications. All tests require access to the option terminal connectors through the rear door . System orientated operational verification tests are included in Section VII, Troubleshooting Aids.

NOTE

Performance tests for the -hp- Model 3495A Scanner can be performed in any order. The sequence described for each performance test must be followed to obtain valid test results.

4-3. EQUIPMENT REQUIRED.

4-4. Testing all 3495A option channels throughout the entire set of specifications can be time consuming. For this reason the performance test procedures given in this section are shown for representative (worst-case where possible) channels using minimum equipment configurations. The section ends with some suggestions on automating the 3495A performance test process and suggested equipment for such a process.

4-5. Table 4-1 lists the recommended equipment for testing the 3495A Scanner performance against specifications. If the recommended equipment is not available, use substitute equipment that has required capabilities.

4-6. PERFORMANCE TEST CARD.

4-7. A Performance Test Card is provided at the end of this section for your convenience in recording the performance of the 3495A during performance tests. This card can be removed from the manual and used as a permanent record of the incoming inspection or of a routine performance test. The Performance Test Card may be reproduced without written permission from Hewlett-Packard.

4-8. CALIBRATION CYCLE.

4-9. The 3495A does not require periodic verification of performance. The performance should be tested as part of the incoming inspection.

4-10. PERFORMANCE TEST FAILURE.

4-11. If the 3495A fails any of the performance tests, refer to Section VII for troubleshooting information. Shorted, open, or resistive relays will cause failures in the 9825A based performance tests.

NOTE

A shorted or out-of-sequence relay may cause test failures on a series of channels. If a test does indicate a series of faults, check the last good channel as well as the faulty ones.

4-12. SWITCHING TIME TEST.

4-13. Specifications.

4-13(a). The following specifications are verified in this test:

Opt 001&003	Opt 002	Opt 004&005
≤ 10 msec	≤ 40 msec	≤ 1 msec

4-14. Description.

4-15. This test verifies that the 3495A Scanner can switch channels within the specified time. Some theory behind this test may help. In general, the test incrementally steps channels through a 20-to-1 or a 10-to-1 voltage divider at the maximum switching rate of the option storing the measurements on each channel. The test *requires* an option 100 control board to provide the specified incrementation speed. A fast sampling voltmeter (-hp- 3437A) is required to take the measurements and provide increment pulses (delay out). The controller requires some form of fast data storage equivalent to the switching rate being tested. An -hp- 9825A Calculator using a type 3 high speed I/O buffer is the recommended controller for this test.

4-16. Test Procedure.

EQUIPMENT REQUIRED:

3495A Option 100/Accessory 44413A
Calculator (-hp- 9825A w/General & Extended I/O ROM's)
Digital Voltmeter (-hp- 3437A)
HP–IB Card (-hp- 98034A)
10 or 20 1/8 watt, 1 K ±1% resistors (-hp- 0757-0280)
DPDT switch (1) (-hp- 3101-1235)

a. Connect the test setup as shown in Figure 4-2.

b. Wire the divider network as shown in Figure 4-1.

c. Cycle through the channels to be tested at the specified switching speed and store the measurements.

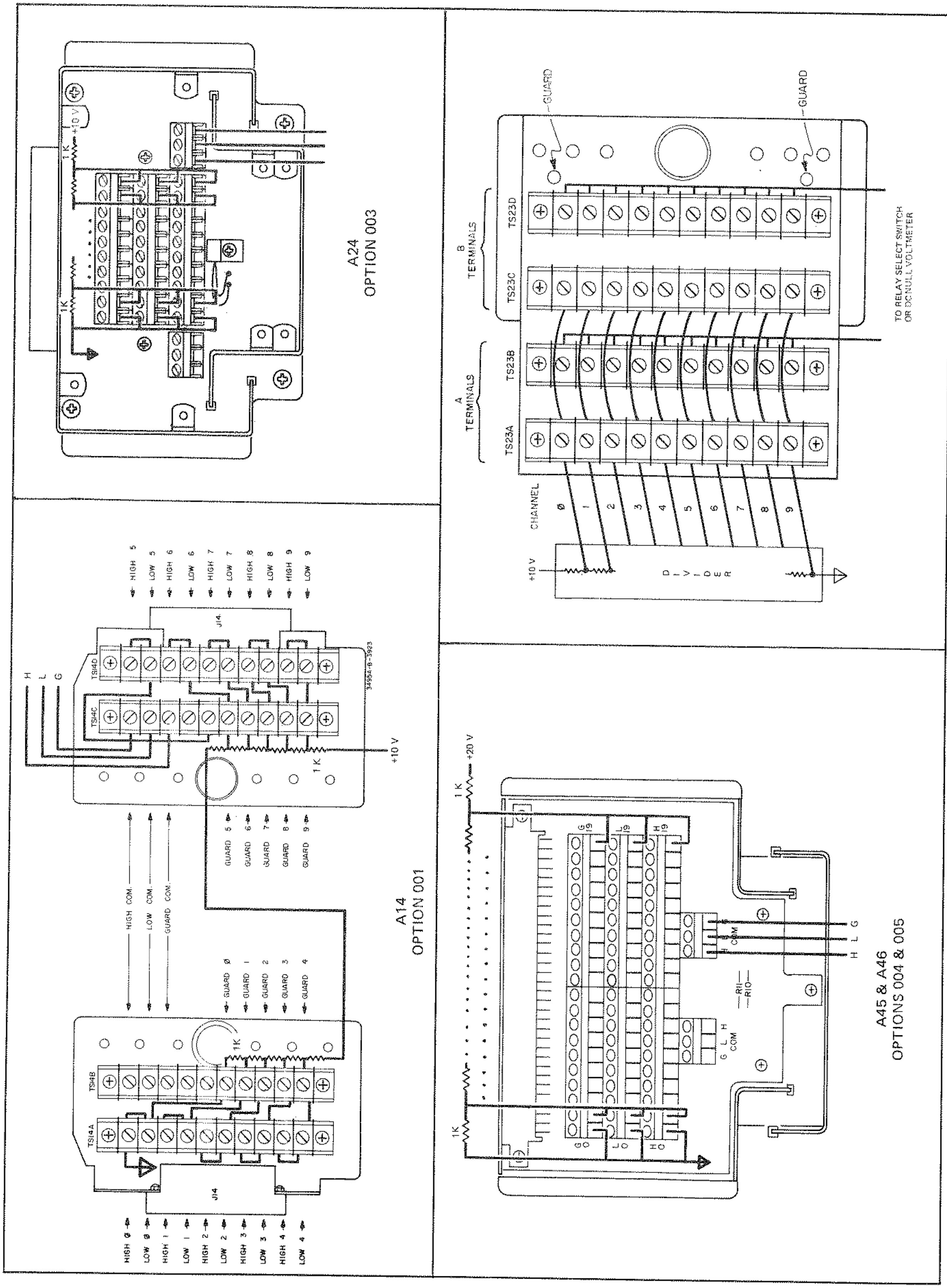


Figure 4-1. Switching Time And Thermal Offset Voltage Test Wiring Diagrams.

The dc supply should be adjusted as follows:

Options 001, 002, & 003: 10 V
Options 004 & 005: 20 V

d. Review the stored measurements and determine if they are within error limitations for the divider. Faulty relays will generally give near ground or out-of-sequence measurements.

4-17. The 9825A sample program shown in Figure 4-3 can be used to test switching time performance of all 3495A options. It is necessary to initialize a few user dependent variables first:

O–Option to be tested (1 through 5)
A–Option close address (20, 40, etc.)

Line 18 has been left blank to include an optional prt V[I] statement for viewing channel measurements.

4-18. THERMAL OFFSET VOLTAGE TEST.

4-19. Specifications.

4-19(a). The following specifications are verified in this test:

Opt 001&003	Opt 002	Opt 004&005
< 2 μV	< 30 μV	< 1 μV

4-20. Description.

4-21. This test verifies that the thermal offset voltage between terminals is within the specified range. The channels are terminated in a short for this test. Low thermal channel measurements are made at the common terminals. Actuator channel measurements are made on the individual channel to be tested.

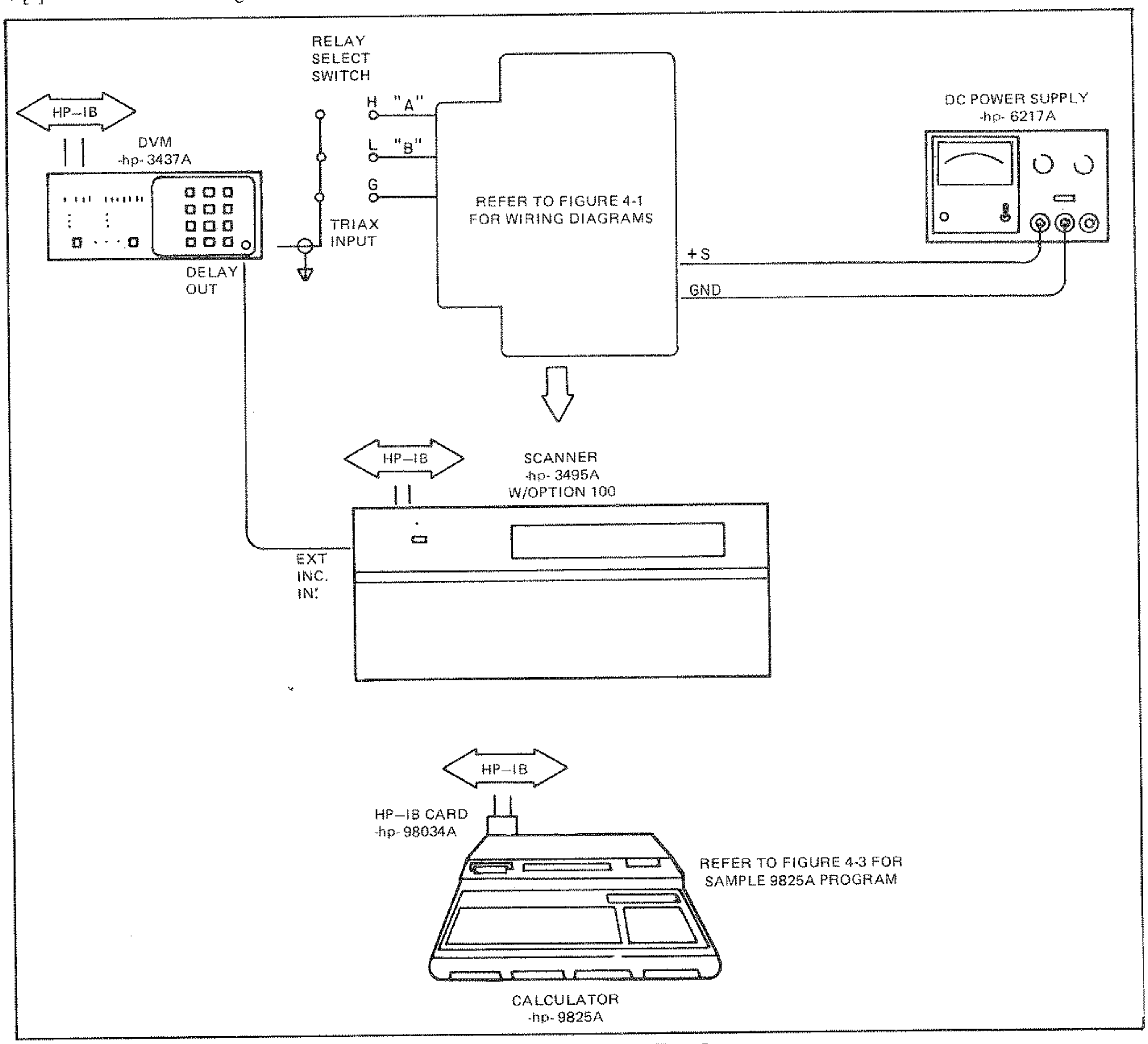


Figure 4-2. Switching Time Test Setup.

```
0: "START":dim V[21]
1: ent "Option Nuumber",O;if O=1 or O=3;.01→D;10→L
2: if O=2;.04→D;10→L
3: if O=4 or O=5;.001→D;20→L
4: ent A
5: dev "scan",709,"svm",724
6: buf "BUFFER",141,3;rem 7
7: fmt 1,"L",f3.0,"F",f3.0,"I1"
8: fmt 2,"R3T1F1N",f2.0,"SD",f7.5,"S"
9: fmt 3
10: "TEST":ent "Press CONTINUE for the Test",Y
11: wrt "scan.1",A+L-1,"C",A
12: wrt "svm.2",L,D
13: tfr "svm","BUFFER"
14: if rds("BUFFER")<0;gto +0
15: wtb "svm","T3"
16: for I=1 to L
17: red "BUFFER.3",V[I]
18:
19: next I
20: if O=2;gto "CHK2"
21: for I=1 to L
22: if prnd(V[I],0)#I-1;prt "FAULT",A+I-1;1→Q
23: next I
24: gto "OK"
25: "ACT":
26: "CHK2":if prnd(V[1],0)#9;prt "FAULT",A
27: for I=1 to 9
28: if prnd(V[I+1],-1)=prnd(V[I],-1);prt "FAULT",A+I;1→Q
29: next I
30: if prnd(V[10],-1)#0;prt "FAULT",A+9
31: "OK":if Q#1;prt "Option",O,"        OK";spc
32: end
*3732
```

Figure 4-3. Sample 9825A Switching Time Test.

4-22. Test Procedure.

EQUIPMENT REQUIRED.
3495A Option 100/Accessory 44413A
DC Null Voltmeter (-hp- 419A)

a. Connect the test setup as shown in Figure 4-4. The connector wiring in Figure 4-1 can be used for this test also.

b. Place a shorting strap directly across the DC NULL VOLTMETER inputs.

c. Zero the DC NULL VOLTMETER on the 3 micro-volt range.

d. Increment the SCANNER to the channel to be tested.

e. Remove the shorting strap from the DC NULL VOLTMETER.

f. Record the measurement on the performance test card at the end of this section.

g. Repeat Steps b through f for all channels to be tested. The actuator channel measurements require rewiring the connector for each channel measured, unless common connections are wired as in Figure 4-1.

4-23. CHANNEL ISOLATION TEST.

4-24. Specifications.

4-24(a). The following specifications are verified in this test:

Opt 001&003	Opt 004&005
$> 10^{10}\ \Omega$	$> 10^{7}\ \Omega$

NOTE

These are strictly resistive quantities.

4-25. Description.

4-26. This test verifies that the isolation resistance on option channels is within the specified range. The test requires a *high resistance meter* since $> 10^{10}$ or $> 10^{7}$ ohm measurements are expected. There are three isolation resistances which can be tested. They are:

High-to-Low
High-to-Guard
Low-to-Guard

as determined by the Select Switches S1 and S2 in Figure 4-6.

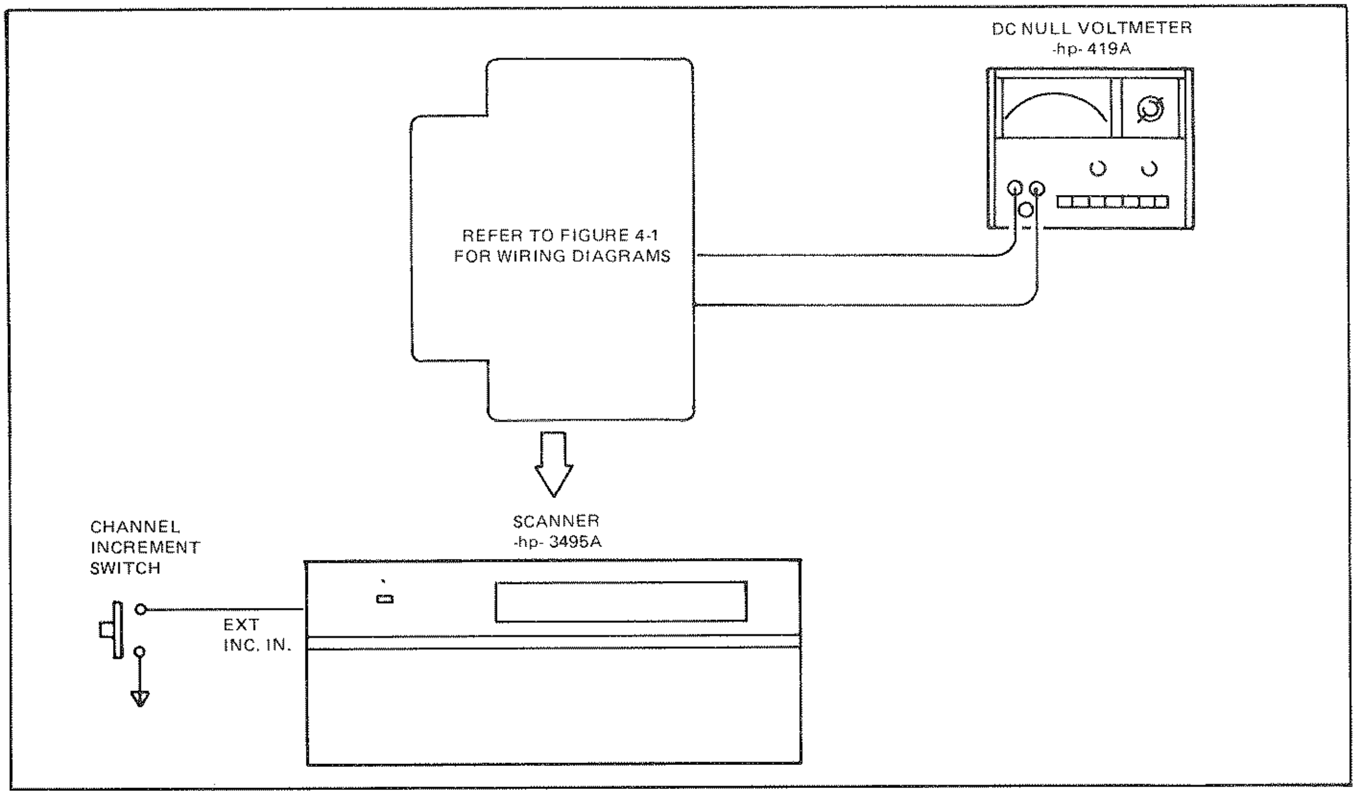


Figure 4-4. Thermal Offset Voltage Setup.

4-27. Test Procedure.

EQUIPMENT REQUIRED:

3495A Option 100/Accessory 44413A
Digital Multimeter (-hp- 3455A)
High Resistance Meter (-hp- 4329A)
DPDT Switch (2) (-hp- 3101-1235)

a. Connect the test setup as shown in Figure 4-6. Use the proper value for R_S as shown in Table 4-2.

b. Wire the Option Connector as shown in Figure 4-5.

c. Install the connector into the scanner.

d. Increment the scanner to the channel you wish to test.

e. Set the *high resistance meter* controls as follows:

FUNCTION . . . . RESISTANCE

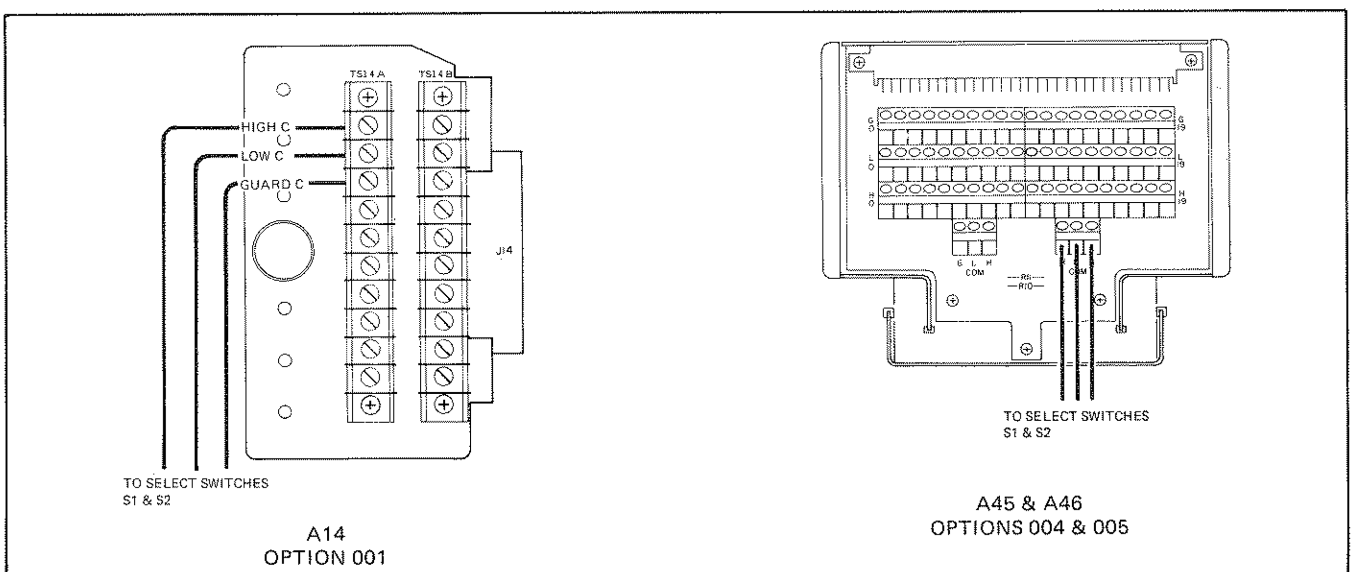


Figure 4-5. Channel Isolation Test Wiring Diagrams.

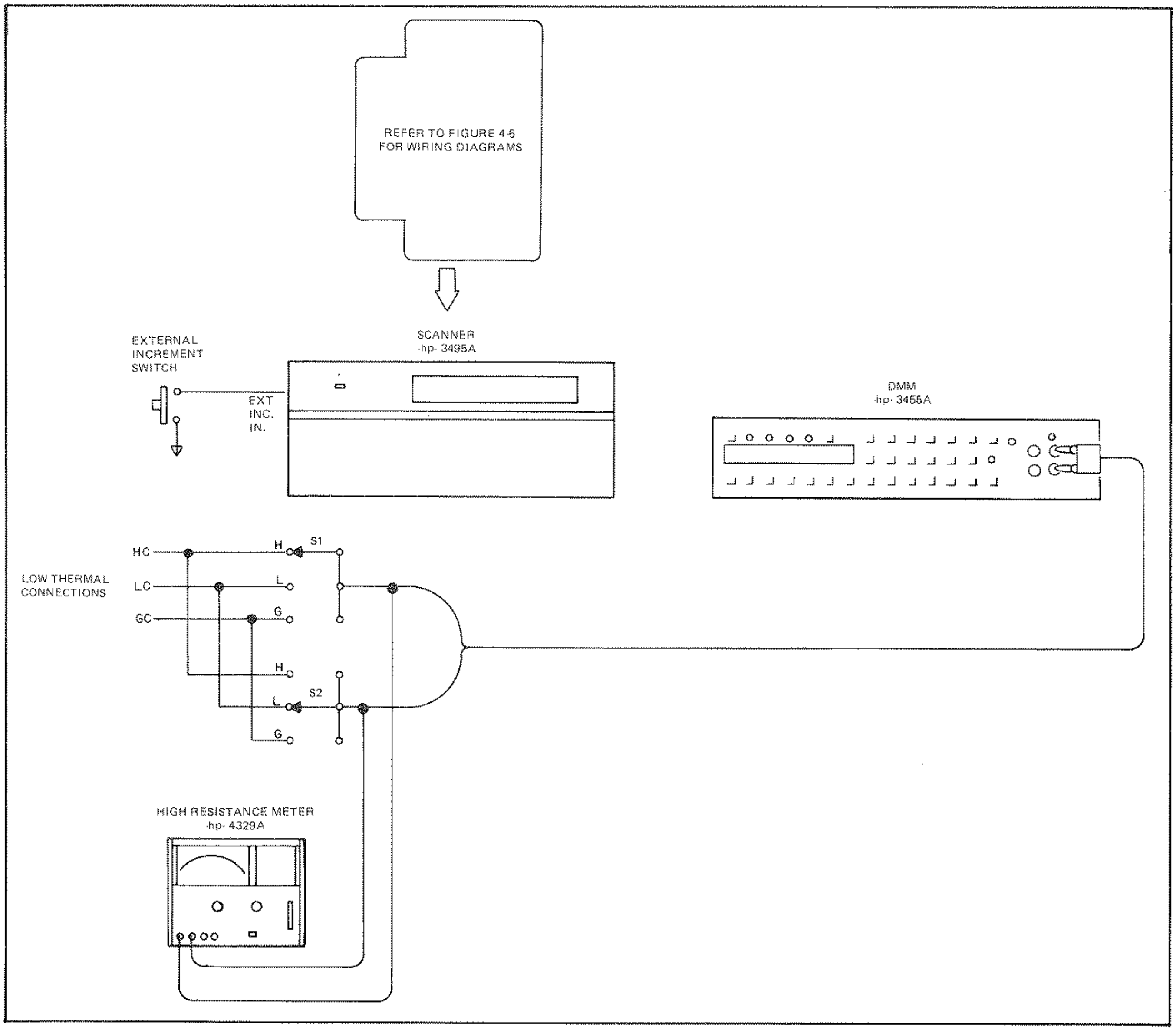


Figure 4-6. Channel Isolation Test Setup.

MODE.	DISCHARGE
TEST VOLTAGE	25 VOLTS
RANGE.	$X10^{10}$ Option 002
	$X10^{7}$ Others

f. Select the isolation you wish to test with switches S1 and S2.

g. After the high resistance meter has stabilized, set the *mode* switch to *charge*.

h. Allow several seconds for the meter circuitry to charge. Then set the *mode* switch to *measure*.

i. Record the isolation resistance on the performance test card at the rear of this section.

j. Repeat Steps d through i for each isolation you wish to test.

k. Repeat Steps d through j for each channel you wish to test.

4-28. CAPACITANCE TEST.

4-29. Specifications.

4-29(a). The following specifications are verified in this test:

	Opt 001	Opt 002	Opt 004
High-to-Low Channel Capacitance			
Open:	< 15 pF	< 15 pF	< 350 pF
Closed:	< 15 pF	< 25 pF	< 400 pF
Interchannel Capacitance	< 12 pF	< 12 pF	< 10 pF

4-30. Description.

4-31. This test verifies that the high-to-low or "A"-to-"B" capacitances and interchannel capacitances are below the specified values. Channels can be closed by an external increment input closure to ground. A momentary contact switch can serve to make these closures. Low thermal measurements are made from the connector COMMON terminals. Actuator channel measurements are made on individual channels. Interchannel capacitances are made from channel input terminals.

NOTE

The suggested FLC meter requires a one hour warmup time.

4-32. Test Procedure.

EQUIPMENT REQUIRED:
3495A Option 100/Accessory 44413A
R L C Meter (-hp- 4271B)
w/16032A Test Lead Accessory

a. Connect the test setup as shown in Figure 4-8. Allow the R L C meter 1 hour warmup time before proceeding.

b. Before connecting the test leads (twisted pair and guard) to the scanner connector, set the R L C METER as follows and then zero the meter.

FUNCTION . . . . C–G
RANGE. . . . . AUTO
SIG LEVEL .HIGH
TRIGGER . . . . INT
RATE . . . . FULLY CLOCKWISE (Max)

Zeroing the meter eliminates the effects of the inherent test lead capacitance.

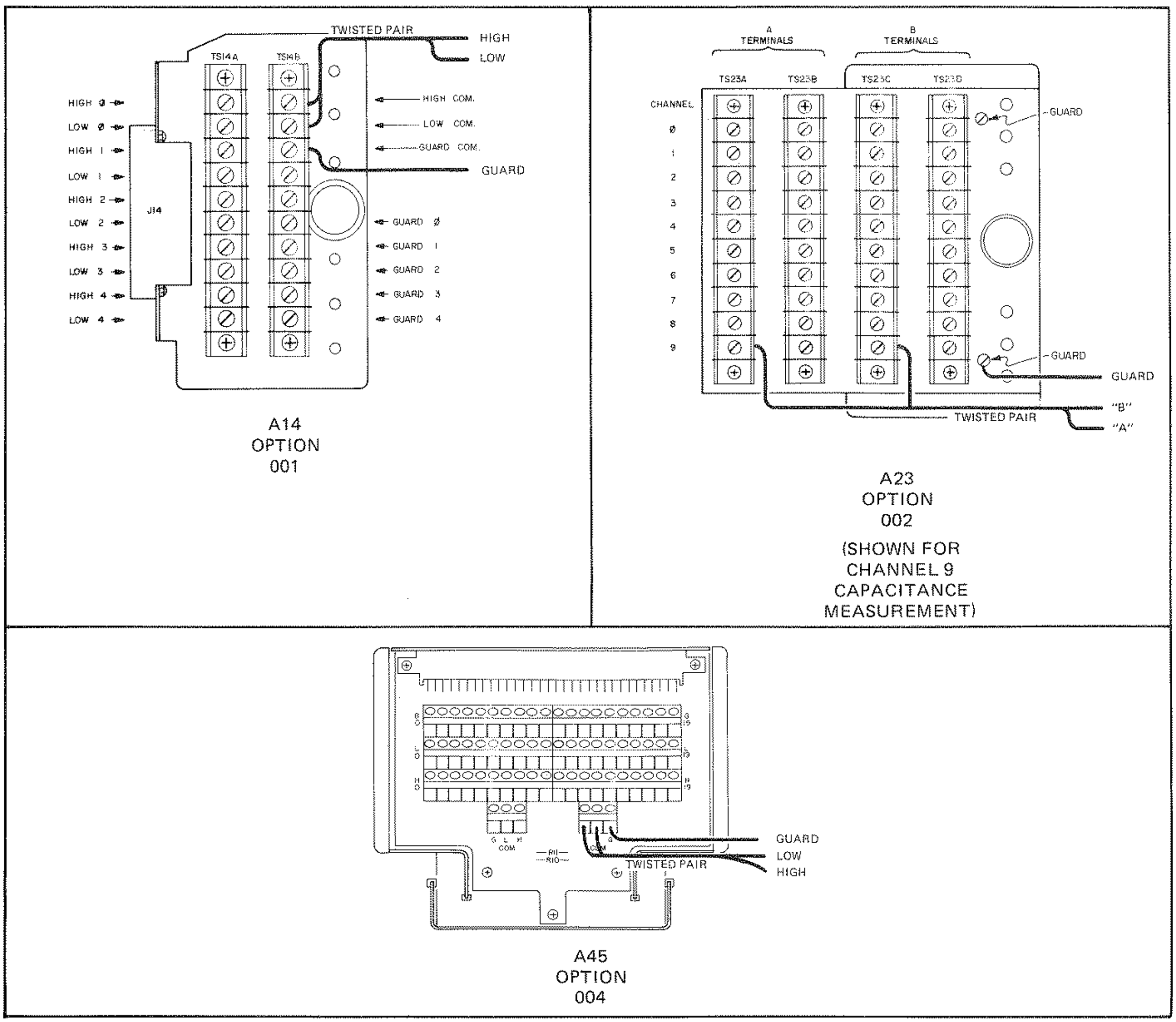


Figure 4-7. Capacitance Test Wiring Diagrams.

c. Connect the twisted pair to high common and low common on the connector or to "A" and "B" of the Option 002 channel you wish to test. Connect the test lead terminal shield to *guard common* on the connector.

d. Install the connector into the SCANNER.

e. Increment the scanner to the channel you wish to test. The worst-case channels are listed below and on the Performance Test Card.

Option 001 . . . . 4, 9
Option 002 . . . . .0, 9, 1, 8
Option 004 . . . . 3, 7, 11, 15, 19

Since the channel capacitances are physically determined, measurements on these channels should be conclusive.

f. Record the measured capacitance on the performance test card at the rear of this section.

g. Repeat Steps e and f for all channels to be tested. Interchannel capacitances are made between channel input terminals with one (low thermal options) or both (actuator option) channel(s) closed.

4-33. FREQUENCY RESPONSE TEST.

4-34. Specifications.

4-34(a). The following specifications are verified in this test:

Frequency Response (10 kHz reference, 50 ohm load)

Option 001: Up to 100 kHz: ± 0.3 dB
Up to 1 MHz: ± 0.5 dB

Option 002: Up to 100 kHz: ± 0.3 dB
Up to 1 MHz: ± 0.5 dB

Option 004: Up to 1 MHz: ± 0.20 dB

4-35. Description.

4-36. This test verifies that the scanner's frequency response is within the specified range. Channels can be closed by an external increment input closure to ground. A momentary contact switch can serve to make these closures. Low thermal measurements are made from the connector COMMON terminals. Actuator channel measurements are made on individual channels. Worst-case channels for this test are:

Option 001 . . . . 9, 4
Option 002 . . . . 0, 9
Option 004 . . . . 3, 7, 11, 15, 19

Measurements on these channels should be conclusive.

4-37. Test Procedure.

EQUIPMENT REQUIRED:

3495A Option 100/Accessory 44413A
Test Oscillator (-hp- 652A)
Digital Multimeter (-hp- 3455A)
50 ohm Termination (-hp- 11048C)
BNC-BNC Cable (2) (-hp- 11170A)
BNC-Banana Adapter (-hp- 1251-2277)

a. Connect the test setup as shown in Figure 4-10. Do not wire the connector at this time.

b. Set the *Test Oscillator* controls as follows:

RANGE. . . . . X 1 K } 10 kHz
VERNIER . . . . 10 } Frequency
OUTPUT ATTENUATOR. . . . . 3.0 volts

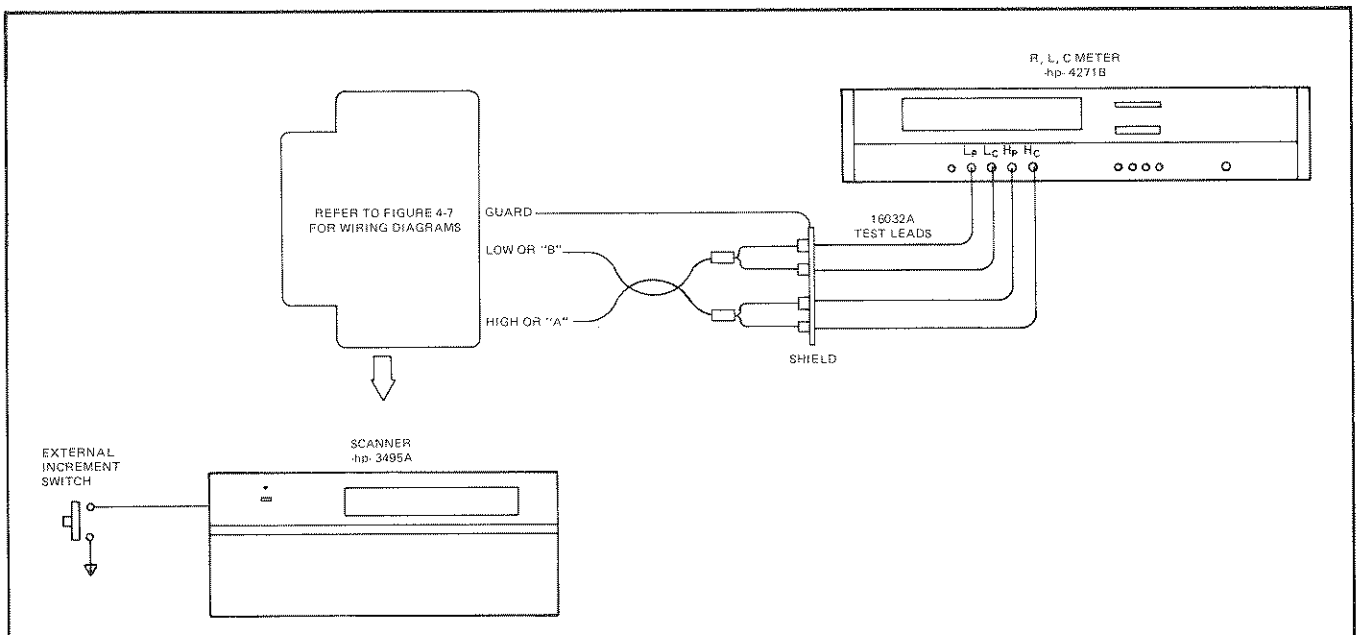


Figure 4-8. Capacitance Test Setup.

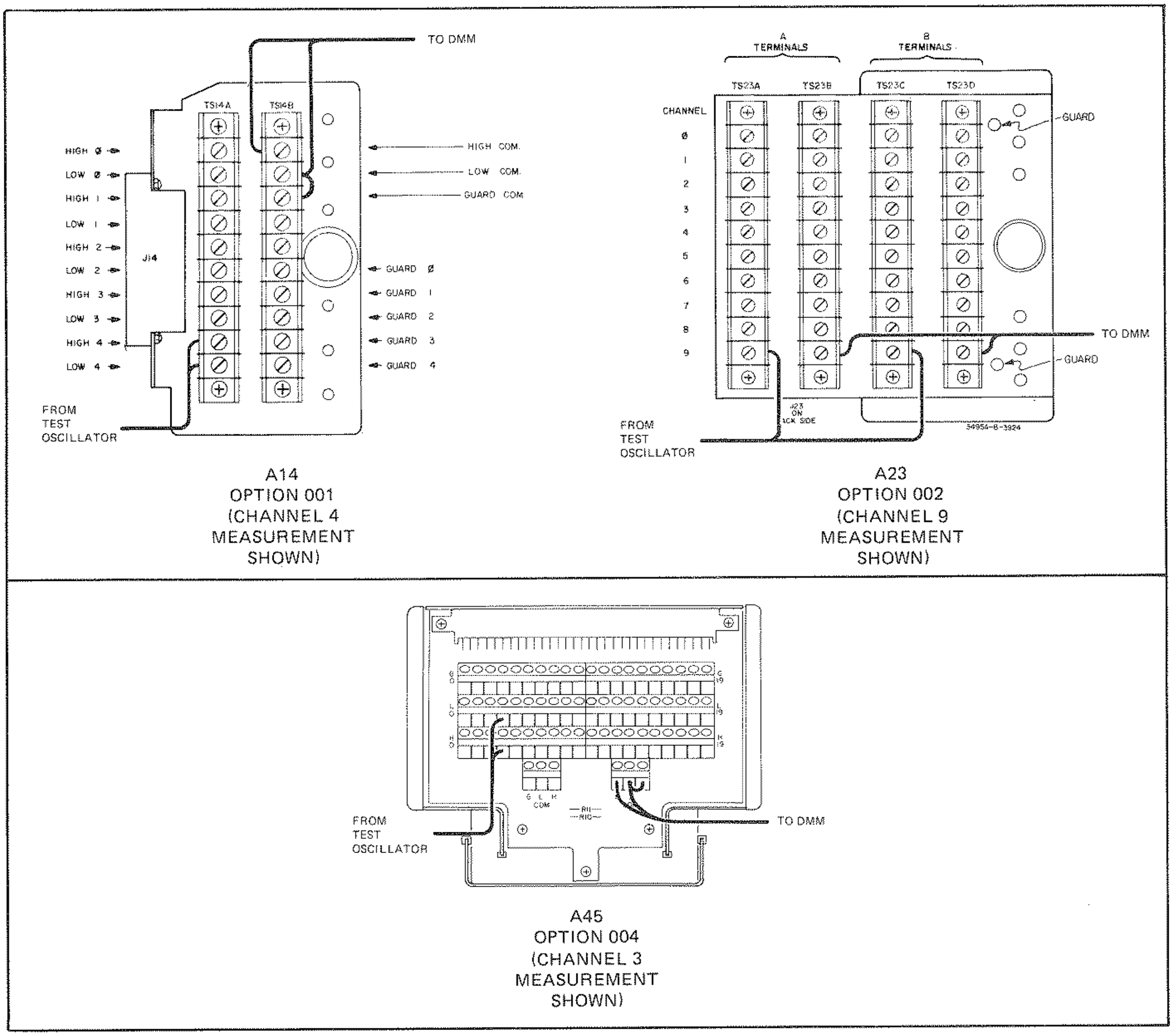


Figure 4-9. Frequency Response Test Wiring Diagrams.

c. Set the DMM controls as follows:

RANGE. . . . . AUTO
(for auto-ranging DMM's)
FUNCTION . . . . ACV
TRIGGER . . . . INTERNAL
AUTO CAL . . . . ON
GUARD . . . . .DEPRESSED
(Guard to Low Connection)

d. Connect the *Test Oscillator* 50 ohm output to the DMM via a 50 ohm feedthrough termination (-hp- 11048C).

e. Adjust the test oscillator output to a DMM reading of 3.0000 volts.

f. Wire the option connector to the input terminals of the channel to be tested. Refer to Figure 4-9 for representative wiring.

g. Install the connector into the SCANNER.

h. Increment the scanner to the channel to be tested. Worst-case channel measurements should be adequate.

i. Record the 10 kHz reference value, V_{REF}, on the performance test card at the end of this section. This measurement is required for each channel to be tested, therefore, you may wish to take this measurement on all of them now.

j. Reset the *Test Oscillator* controls as follows:

RANGE. . . . . X 10 } 100 Hz
VERNIER . . . . 10 } Frequency
OUTPUT ATTENUATOR. . . . . 3.0 volts

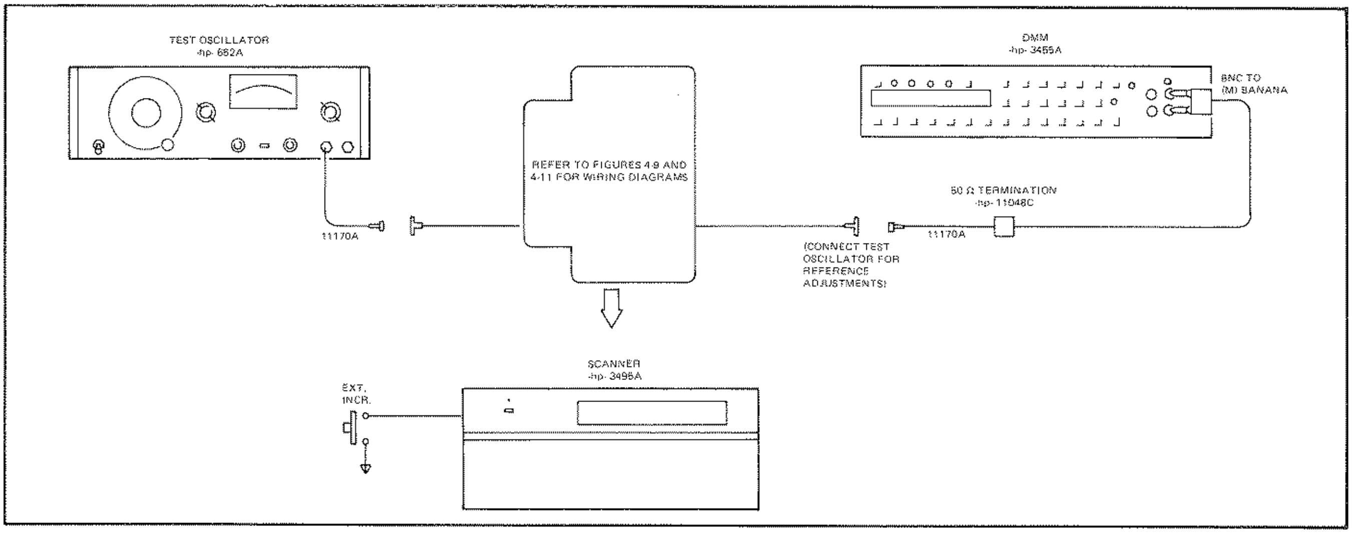


Figure 4-10. Frequency Response Test Setup.

Table 4-2. V/V_{REF} Test Limits.

Frequency (Hz)	V/V_{REF} Limits Lower – Upper Option 001	Option 002	Option 004
100	.9660 – 1.0351	.9660 – 1.0351	.9772 – 1.0233
10 K	Reference	Reference	Reference
50 K	.9660 – 1.0351	.9660 – 1.0351	.9772 – 1.0233
100 K	.9660 – 1.0351	.9660 – 1.0351	.9772 – 1.0233
500 K	.9440 – 1.0593	.9440 – 1.0593	.9772 – 1.0233
1 M	**.9440 – 1.0593**	**.9440 – 1.0593**	**.9772 – 1.0233**

NOTE: *Bold values can be used as an abbreviated test.*

k. Connect the test oscillator 50 ohm output to the DMM via a 50 ohm feedthrough termination (disconnect from Scanner).

l. Adjust the test oscillator output for a DMM reading of 3.0000 volts.

m. Reconnect the test oscillator to the scanner as shown in Figure 4-10.

n. Record the DMM reading, V, on the Performance Test Card at the end of this section.

o. Verify that the ration V/V_{REF} is within the limits shown in Table 4-2.

NOTE

It is necessary to adjust the **Test Oscillator** *back to 3.0000 volts after each change of frequency. This occurs twice per channel measurement.*

p. Repeat Steps b through o for each channel to be tested, adjusting the test oscillator frequency in Step J to the values listed in Table 4-2.

4-38. AUTOMATING THE TEST PROCESS.

4-39. Because of the repetitive nature of testing scanner channel performance, the test process is easily automated. An HP–IB test system can be developed around equipment such as that listed in Table 4-3. Such a system reduces the quantity of wiring and measurement recording which was necessary in the manual procedures, although requiring somewhat more elaborate equipment.

Table 4-3. Suggested Test System Equipment.

Instrument	Specifications	Suggested -hp- Model
Calculator	HP–IB Controller Capability High-Speed I/O ≥1 msec/measurement	9825A
DVM	Reading Rate: Options 001 & 003: ≤10 msec Option 002: ≤40 msec Options 004 & 005: ≤1 msec Delay Output HP–IB Compatible	3437A
Automatic Synthesizer	To 1 MHz HP–IB Compatible	3330B
Network Analyzer	To 1 MHz HP–IB Compatible Dual Channel: Reference&Test	3570A

PERFORMANCE TEST CARD

Hewlett-Packard Model 3495A
Instrument Serial No. ____________________

Test Performed By ____________
Date ____________

Test	Specification	Test Results			
		Option:	Option:	Option:	Option:
		Address:	Address:	Address	Address:
Switching Time	Option 001: ≤10 ms Option 002: ≤40 ms Option 003: ≤10 ms Option 004: ≤1 ms Option 005: ≤1 ms	Pass ____ Fail ____ Faulty Channels ____	Pass ____ Fail ____ Faulty Channels ____	Pass ____ Fail ____ Faulty Channels ____	Pass ____ Fail ____ Faulty Channels ____

Test	Specification	Measurement	Measurement	Measurement	Measurement
Thermal Offset Voltage	Option 001: < 2 µV				
	Option 002: < 30 µV				
	Option 003: < 2 µV				
	Option 004: < 1 µV				
	Option 005: < 1 µV				

Test		Measurement	Measurement	Measurement	Measurement
Channel Isolation	Specification				
	Option 001: $> 10^{10}\ \Omega$				
	Option 003: $> 10^{10}\ \Omega$				
	Option 004: $> 10^{7}\ \Omega$				
	Option 005: $> 10^{7}\ \Omega$				

Test	Specification	Test Results Option	 Option	 Option	 Option
Capacitance	High-to-Low or "A"-to-"B" Capacitance	H-to-L or A-to-B	H-to-L or A-to-B	H-to-L or A-to-B	H-to-L or A-to-B
	Opt 001 Opt 002 Opt 004	______	______	______	______
	Open: < 15 pF < 15 pF < 350 pF	______	______	______	______
	Closed: < 15 pF < 25 pF < 400 pF	______	______	______	______
		______	______	______	______
		______	______	______	______
	Interchannel Capacitance				
	Opt 001 Opt 002 Opt 004 < 12 pF < 12 pF < 10 pF	Inter- Channel H-to-H or A-to-A	Inter- Channel H-to-H or A-to-A	Inter- Channel H-to-H or A-to-A	Inter- Channel H-to-H or A-to-A
	Worst Case Channels	______	______	______	______
	"High" to "Low"	______	______	______	______
	Option 001: 9*, 4*	______	______	______	______
	Option 004: 3*,7*,11*,15*,19*	______	______	______	______
	"A" to "B"	______	______	______	______
	Option 002: 0*, 9*				
	"Interchannel"				
	Option 001: 4*-to-3 9*-to-8				
	Option 002: 0*-to-1* 9*-to-8*				
	Option 004: 3*-to-2 7*-to-6 11*-to-10	L-to-L or B-to-B	L-to-L or B-to-B	L-to-L or B-to-B	L-to-L or B-to-B
	15*to-14 19*-to-18	______	______	______	______
	* Closed For Measurement	______	______	______	______
		______	______	______	______
		______	______	______	______
		______	______	______	______

		Channel	Ratio	Channel	Ratio	Channel	Ratio	Channel	Ratio
Frequency Response (10 kHz Reference, 50 Ω Load)	OPTION 001								
	Up to 100 kHz: ± .3 dB	___	___	___	___	___	___	___	___
	Up to 1 MHz: ± .5 dB	___	___	___	___	___	___	___	___
		___	___	___	___	___	___	___	___
	OPTION 002	___	___	___	___	___	___	___	___
	Up to 100 kHz: ± .3 dB	___	___	___	___	___	___	___	___
	Up to 1 MHz: ± .5 dB								
	OPTION 004								
	Up to 1 MHz: ± .2 dB								
	Worst Case Channels Option 001: 9, 4 Option 002: 0, 9 Option 004: 3,7,11,15,19								
	Test Limits (V/V_{REF} Ratio) OPTION 001 Freq (Hz) — Lower—Upper 100 — .9660 – 1.0351 10 K — Reference 50 K — .9660 – 1.0351 100 K — .9660 – 1.0351 500 K — .9440 – 1.0593 1 M — .9440 – 1.0593								
	OPTION 002 Freq (Hz) — Lower – Upper 100 — .9660 – 1.0351 10 K — Reference 50 K — .9660 – 1.0351 100 K — .9660 – 1.0351 500 K — .9440 – 1.0593 4 M — .9440 – 1.0593								
	OPTION 004 Freq (Hz) — Lower – Upper 100 — .9772 – 1.0233 10 K — Reference 50 K — .9772 – 1.0233 100 K — .9772 – 1.0233 500 K — .9772 – 1.0233 1 M — .9772 – 1.0233								

SECTION V
ADJUSTMENTS

5-1. POWER SUPPLY ADJUSTMENT.

5-2. Only one adjustment is required on the 3495A, the + 5 V Power Supply Adjustment. Use the following procedure:

a. Remove the 3495A top cover by turning the screw at the rear and pulling rearward on the cover.

b. Connect a voltmeter across the + 5 and GND pins on the A2 assembly. See Figure 7-A-2 in Service Group A for the location of A2 and the two pins.

c. Adjust A2R1 to give a reading on the voltmeter of + 5 V ± 3%. This adjustment screw is shown in Figure 5-1.

d. Remove the voltmeter and replace the 3495A top cover.

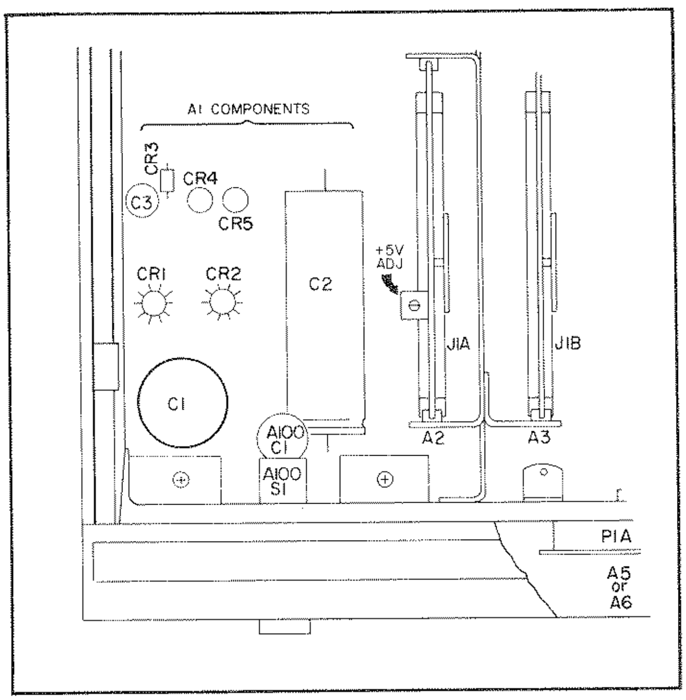


Figure 5-1. Five (5) Volt Adjustment.

SECTION VI
REPLACEABLE ASSEMBLIES

6-1. INTRODUCTION.

6-2. This section contains information for ordering replacement assemblies. Table 6-3 lists the assemblies in alphameric order of their reference designators.

6-3. Replaceable Parts.

6-4. Tables containing the following information on replaceable parts for each assembly are listed in the Service Group where the assembly is found.

a. -hp- Part Number.

b. Total quantity used in the instrument (Qty column). The total quantity of a part is given the first time the part number appears.

c. Description of the part. (See Table 6-1 for abbreviations.)

d. Typical manufacturer of the part is a five-digit code. (See Table 6-2 for list of manufacturers.)

e. Manufacturers part number.

6-5. ORDERING INFORMATION.

6-6. To obtain replacement assemblies or parts, address your order or inquiry to the nearest Hewlett-Packard Sales and Service Office. Identify assemblies and parts by their -hp- Part Numbers. Include the instrument model and serial number.

6-7. Non-Listed Parts.

6-8. To obtain a part that is not listed in the service groups, include:

a. Instrument model number.
b. Instrument serial number.
c. Description of the part.
d. Function and location of the part.

Table 6-1. Standard Abbreviations.

ABBREVIATIONS

Abbreviation	Meaning
Ag	silver
Al	aluminum
A	ampere(s)
Au	gold
C	capacitor
cer	ceramic
coef	coefficient
com	common
comp	composition
conn	connection
dep	deposited
DPDT	double-pole double-throw
DPST	double-pole single-throw
elect	electrolytic
encap	encapsulated
F	farad(s)
FET	field effect transistor
fxd	fixed
GaAs	gallium arsenide
GHz	gigahertz = 10^{+9} hertz
gd	guard(ed)
Ge	germanium
gnd	ground(ed)
H	henry(ies)
Hg	mercury
Hz	hertz (cycle(s) per second)
ID	inside diameter
impg	impregnated
incd	incandescent
ins	insulation(ed)
kΩ	kilohm(s) = 10^{+3} ohms
kHz	kilohertz = 10^{+3} hertz
L	inductor
lin	linear taper
log	logarithmic taper
mA	milliampere(s) = 10^{-3} amperes
MHz	megahertz = 10^{+6} hertz
MΩ	megohm(s) - 10^{+6} ohms
met flm	metal film
mfr	manufacturer
ms	millisecond
mtg	mounting
mV	millivolt(s) = 10^{-3} volts
μF	microfarad(s)
μs	microsecond(s)
μV	microvolt(s) = 10^{-6} volts
my	Mylar®
nA	nanoampere(s) = 10^{-9} amperes
NC	normally closed
Ne	neon
NO	normally open
NPO	negative positive zero (zero temperature coefficient)
ns	nanosecond(s) = 10^{-9} seconds
nsr	not separately replaceable
Ω	ohm(s)
obd	order by description
OD	outside diameter
p	peak
pA	picoampere(s)
pc	printed circuit
pF	picofarad(s) 10^{-12} farads
piv	peak inverse voltage
p/o	part of
pos	position(s)
poly	polystyrene
pot	potentiometer
p-p	peak-to-peak
ppm	parts per million
prec	precision (temperature coeffient, long term stability and/or tolerance)
R	resistor
Rh	rhodium
rms	root-mean-square
rot	rotary
Se	selenium
sect	section(s)
Si	silicon
sl	slide
SPDT	single-pole double-throw
SPST	single-pole single-throw
Ta	tantalum
TC	temperature coefficient
TiO_2	titanium dioxide
tog	toggle
tol	tolerance
trim	trimmer
TSTR	transistor
V	volt(s)
vacw	alternating current working voltage
var	variable
vdcw	direct current working voltage
W	watt(s)
w/	with
wiv	working inverse voltage
w/o	without
ww	wirewound
*	optimum value selected at factory, average value shown (part may be omitted)
**	no standard type number assigned selected or special type

® Dupont de Nemours

DECIMAL MULTIPLIERS

Prefix	Symbols	Multiplier	Prefix	Symbols	Multiplier
tera	T	10^{12}	centi	c	10^{-2}
giga	G	10^{9}	milli	m	10^{-3}
mega	M or Meg	10^{6}	micro	μ	10^{-6}
kilo	K or k	10^{3}	nano	n	10^{-9}
hecto	h	10^{2}	pico	p	10^{-12}
deka	da	10	femto	f	10^{-15}
deci	d	10^{-1}	atto	a	10^{-18}

STD-B-2734

DESIGNATORS

Designator	Meaning
A	assembly
B	motor
BT	battery
C	capacitor
CR	diode
DL	delay line
DS	lamp
E	misc electronic part
F	fuse
FL	filter
HR	heater
IC	integrated circuit
J	jack
K	relay
L	inductor
M	meter
MP	mechanical part
P	plug
Q	transistor
QCR	transistor-diode
R	resistor
RT	thermistor
S	switch
T	transformer
TB	terminal board
TC	thermocouple
TP	test point
TS	terminal strip
U	microcircuit
V	vacuum tube, neon bulb, photocell, etc.
W	cable
X	socket
XDS	lampholder
XF	fuseholder
Y	crystal
Z	network

Table 6-2. Code List of Manufacturers.

Mfr. No.	Manufacturer Name	Address
00000	U.S.A. Common	Any Supplier of U.S.A.
00779	Amp Inc	Harrisburg, PA 17105
01121	Allen Bradley Co.	Milwaukee, WI 53212
01295	Texas Instr. Inc. Semicond. Cmpnt. Div.	Dallas, TX 75231
04713	Motorola Semiconductor Products	Phoenix, AZ 85008
06540	Amatom Elec. Hardware Div. of Mite	New Rochelle, NY 10802
07263	Fairchild Semiconductor Div.	Mountain View, CA 94040
16299	Corning Gl. Wk. Elec. Cmpnt. Div.	Raleigh, NC 27604
22526	Berg Electronic Inc.	Cumberland, PA 17070
24546	Corning Glassworks	Bradford, PA 16701
27014	National Semiconductor Corp.	Santa Clara, CA 95051
27264	Molex Products Co.	Downers Grove, IL 60515
28480	Hewlett-Packard Co. Corporate HQ	Palo Alto, CA 94304
32997	Bourns Inc. Trimpot Prod. Div.	Riverside, CA 92507
56289	Sprague Electric Co.	North Adams, MA 01247
59730	Thomas & Betts Co. THE	Elizabeth, NJ 07207
71785	TRW Elek Components Cinch Div.	Elk Grove Village, IL 60007
75042	TRW Inc. Philadelphia Div.	Philadelphia, PA 19108
90201	Mallory Capacitor Co.	Indianapolis, IN 46206

Table 6-3. Replaceable Assemblies.

Assembly	-hp- Part No.	Description	Service Group
A1	03495-66501	Mother Bd. Assy: Standard	A
A2	03495-66524	PC Assy: Standard	
A3	03495-66503	Connector Assy: Standard	
A4	03495-66504	Interface and Control: Standard	
A7	03495-66507	Extender Assy: Standard	
A100	None	Chassis: Standard	
A5	03495-66505	Low Thermal Display: Options 001&003	B
A10	03495-66510	Low Thermal Logic Assy: Options 001&003	
A13*	None	Low Thermal Channel Assy: Options 001&003	
A14	03495-64101	Low Thermal Terminal Assy: Option 001	
A24	03495-64103	Reference Connector Assy: Option 003	
A6	03495-66506	Actuator Display Assy: Option 002	C
A20	03495-66520	Actuator Logic Assy: Option 002	
A21	03495-66521	Actuator Terminal Assy: Option 002	
A22*	None	Actuator Channel Assy: Option 002	
A5	03495-66505	Low Thermal Display: Options 004&005	D
A40	03495-66540	Duo-Decade Logic Assy: Options 004&005	
A25	03495-66525	Duo-Decade Channel Assy: Options 004&005	
A41	03495-66541	Duo-Decade Coil Assy:Options 004&005	
A42	03495-66542	Duo-Decade Reed Assy: Options 004&005	
A45	03495-64114	Duo-Decade Terminal Assy: Option 004	
A46	03495-64115	Duo-Decade Reference Connector Assy: Option 005	
A8	03495-66508	Fast Controller Assy: Option 100 (Replaces A4)	E

*These assemblies are not available individually.

WARNING

These servicing instructions are for use by trained service personnel only. To avoid electrical shock, do not perform any servicing other than that contained in the operating instructions unless you are qualified to do so.

SECTION VII
SERVICE

7-1. THE SERVICE GROUP CONCEPT.

7-2. This section of the manual is organized to streamline service procedures on the 3495A Scanner. The material is divided into service "Groups". Each Service Group contains the following information:

a. Cover Page – Describes which options and assemblies are covered in the Service Group. This page is illustrated with a block diagram showing the assembly functions.

b. Introduction – Describes and outlines the Service Group.

c. Theory – Describes the Theory of Operation of all assemblies in the Service Group.

d. Troubleshooting – Includes checks and conceptual troubleshooting when flowcharts are not practical.

e. Service Material – Each schematic is preceded by:

1. Block Diagram
2. Troubleshooting Tree
3. Replaceable Parts List
4. Component Locator

7-3. All necessary information for servicing a particular service group is located *in the Service Group.* If a revision is made to any part of a Service Group, the entire service group is revised and the old service group can be used as backdating material.

7-4. SAFETY.

7-5. Take extreme care when servicing the 3495A terminal connectors when using channels for power control or when connected to potentially live circuits.

WARNING

Remove power from all external circuits connected to the 3495A terminal connectors **before** *beginning any service routines. We also suggest disconnecting the channel wires from the connector, regardless of the external circuitry capabilities.*

7-6. RECOMMENDED SERVICE EQUIPMENT.

7-7. Table 7-1 lists the recommended service equipment for the 3495A and all options.

Table 7-1. Recommended Service Equipment.

Instrument	Critical Specifications	Recommended Model
Digital Voltmeter	Reading Rate ⩾1000 readings/sec[1]	-hp- Model 3437A[1] or -hp- Model 3466A
Oscilloscope	Standard	-hp- Model 1740A
Calculator	HP–IB Controller Capability	-hp- Model 9825A with General and Extended I/O ROM
HP–IB Connector		-hp- Model 98034A HP–IB Card
Signature Analyzer*	SA Compatible	-hp- Model 5004A Signature Analyzer
Logic Probe	Standard	-hp- Model 545A Logic Probe

[1] Duo-Decade Options Only
*Option 100 only

7-8. PRELIMINARY TROUBLESHOOTING.

7-9. Before beginning an in-depth service procedure, check the scanner assemblies for visual signs of trouble. These include burnt or loose components, loose or broken connectors, and possible shorted or open conductors. A preliminary check sheet is in Table 7-2.

NOTE

Pay particular attention to loose or bent pins on terminal channel assembly connectors which require frequent installation and removal.

Table 7-2. Preliminary Check Sheet.

Did You. . .
1. Check power fuse, switches, and cord? ________
2. Check power supply and adjust if necessary? ________
3. Clean and check option connectors? ________
4. Cycle through relays to check for opens or shorts? ________
5. Observe the three-hour thermal settling time for temperature measurements? ________
6. Observe other specifications or operating information? ________

7-10. TROUBLESHOOTING TREES.

7-11. Troubleshooting information for scanner faults related to the A4, A10, A20 and A40 Assemblies is located in Service Groups A, B, C, and D respectively.

7-12. ACCESS FOR SERVICING.

7-13. Access to most areas of the instrument may be gained by removing the top cover. To remove the A5 or A6 displays, the front panel must be removed by loosening the four securing screws on the horizontal tabs behind the panel. The location of the securing screws is shown in Figure 2-2 in Section II, Installation. A single screw secures each display assembly.

WARNING

Be sure the line voltage switch is in the OFF position when removing or installing scanner assemblies.

7-14. Access to the interface and control assembly can be obtained with the use of the extender board (-hp- Part Number 03495-66507) supplied with the 3495A. The Interface and Control assembly and the existing A3 connector must be removed first. The A4 or A8 assembly can be removed from the back of the 3495A by removing the two screws that secure the assembly to the 3495A Chassis. With the A4 or A8 assembly removed, the A3 Connector assembly can be removed from the top of the scanner.

7-15. Fit the extender board into the J1A connector and install the A4 or A8 Interface and Control assembly onto the extender board. The Interface and Control assembly can now be easily accessed for servicing and troubleshooting procedures.

7-16. OVERALL TROUBLESHOOTING.

7-17. If the 3495A Scanner power supplies are operational, the remaining apparent 3495A malfunctions can be broken down into four general categories:

a. Listen addressing of the scanner: Service Group A or E.

b. Decade or duo-decade addressing of the scanner: Service Groups B, C and D.

c. Defective relays: Service Group B, C, or D.

d. Malfunctions elsewhere in the scanner: Appropriate Service Group.

7-18. Malfunctions elsewhere in the scanner are most likely the result of poor assembly connections. Look for repeatability of the malfunction. With a firm knowledge of the faults repeatability, malfunctions can easily be isolated down to a service group and board.

7-19. TROUBLESHOOTING AIDS.

7-20. Service Kit.

7-21. The 44095A Service Kit is designed to facilitate on-site isolation and repair of failures in the -hp- Model 3495A Scanner with Options 001, 002, or 003. By substituting one or more of the six pre-tested PC assemblies in a malfunctioning 3495A and running the appropriate diagnostic programs, board level malfunctions can be easily and quickly located. The troubleshooting trees preceding each schematic can be used to isolate component failures.

7-22. The Service Kit contains diagnostics for -hp- Model 9830A/B and 9825A Calculators. An -hp- Model 3490A Multimeter and a 9866A/B Printer are also required for these programs. For more information on the 44095A Service Kit, refer to -hp- Operating Note, Part Number 44095-90001.

7-23. RELAY REPLACEMENT.

7-24. The instructions in Service Groups B and C present a step-by-step procedure to replace a decade High/Low,

Guard, and/or Actuator relay on the Scanner Relay Board assembly. Instructions for replacing duo-decade relays are in Service Group D.

7-25. Signature Analysis.

7-26. With Option 100, an additional servicing aid is included. A signature analysis routine is stored on the A8 Assembly ROM. More information on SA testing with Option 100 is included in Service Group E.

7-27. Properly installed, accessory/option and a Listen address of ")" are assumed throughout this section. Adjustments are normally not required after scanner servicing.

7-28. Test Kit: Options 001 Through 003.

7-29. Two test kits are available as troubleshooting aids for isolating resistive or shorted relays. The test kit (44195A) can be used to locate faults on decade options (Options 001 through 003).

7-30. OPERATIONAL VERIFICATION CHECK:9830A/B CALCULATOR (TEN CHANNEL OPTIONS).

7-31. Description.

7-32. The Scanner Verification Program selects the DMM OHMS function and measures the input resistance of the LOW THERMAL or ACTUATOR CHANNELS. This determines if each relay in a particular channel does not open or does not close.

7-33. The verification program checks each channel assembly separately in the Scanner under test. Each relay in the channel under test (High, Low, and Guard for the Low Thermal assemblies and for actuator assemblies A and B) is tested by the Scanner Verification Check. If a defective relay is found, the program will print out an error message indicating the defective relay channel number and the type of defect (resistive or shorted).

7-34. In the case of a resistive relay, as soon as the defect is detected the error message is printed.

7-35. If one or more relays are shorted, the program will automatically load in the Scanner troubleshooting program first. This program will instruct the Operator to open certain switches on the Scanner Test Fixture until the shorted relay(s) is found. The program will then output the error message on the printer. Defective relays may be replaced easily and simply by following the Scanner Repair procedures found in Service Groups B and C of this manual.

NOTE

The Verification Check program flowcharts may be found in Figures 7-1 and 7-2.

7-36. EQUIPMENT REQUIRED.

7-37. To run the Scanner Verification Check you will need the -hp- Model 9830A Calculator, -hp- Model 9866A Printer, -hp- Model 3495A Scanner, -hp- Model 3490A Option 30 Multimeter, 3495A/9830A Cassette (-hp- Part No. 44195-10001), Low Thermal and/or Actuator, Scanner Test Fixture (-hp- Part No. 03495-67901 and -hp- Part No. 03495-66522, respectively), and the Fixture Cable Assembly (-hp- Part No. 03495-61605).

7-38. Operating Instructions.

7-39. The Operating Instructions for the Scanner Verification program are divided into three main areas—Equipment Setup, Verification Program Instructions, and Troubleshooting Program Instructions.

a. Equipment Setup. In order to run the Scanner Verification Program, the Low Thermal or Actuator Test Fixture and Fixture Cable must be connected to the channel assembly under test and to the 3490A Multimeter. Refer to the steps below for the proper procedure.

1. Turn the 3490A Multimeter and 3495A Scanner Power switches to OFF.

2. Open the relay access panel on the rear of the Scanner by removing the two retaining screws.

NOTE

Refer to the Relay Replacement Procedures, Service Groups B and C for step-by-step instructions on removal of the rear access panel and terminal assembly.

3. Remove the Terminal assembly from the Decade Channel assembly located on the far right as viewed from the rear of the instrument.

4. Insert the Test Fixture into the appropriate Decade channel assembly. Make sure the Test Fixture connector is making a good electrical connection.

NOTE

The Low Thermal assembly Test Fixture is -hp- Part No. 03495-67901, the Actuator Assembly Test Fixture is -hp- Part No. 03495-66522 and the Fixture Cable Assembly is -hp- Part No. 03495-61605. If you are not sure which assembly is in the location you have selected, you may determine the correct fixture by matching the connectors of the Fixture and the Decade Channel Assembly.

5. Connect the Cinch Connector of the Test Fixture Cable (-hp- Part No. 03495-61605) to the Fixture and the Plug to the rear of the 3490A Multimeter.

6. Set the 3490A and 3495A POWER switches to ON and insert the 3495A/9830A Test Cassette (-hp- Part No. 44195-10001) into the Controller cassette transport.

b. Verification Program Instructions.

1. Before the Verification Program is run you should load the Verification Program Instructions onto the keyboard. To do this Press:

[SCRATCH] [A] [EXECUTE]

then

[LOAD] [4] [EXECUTE]

When the tape has stopped moving, press:

[RUN] [EXECUTE]

NOTE

Load the Special Functions routine before loading the Scanner Verification Check as shown in Step 2.

2. The Scanner Verification Program requires the use of the Special Function Keys. Load the Special Function Key program by pressing:

[LOAD] [K] [E] [Y] [1] [EXECUTE]

When the tape has stopped, load the 3495A Scanner Operational Verification Check by pressing:

[LOAD] [3] [EXECUTE]

When the tape has stopped press:

[RUN] [EXECUTE]

3. Follow the instructions listed by the printer. The 3495A Scanner Verification Program and the Scanner Troubleshooting program are written for a 3495A Scanner Listen address of ")" and a 3490A Multimeter Talk and Listen address of "V" and "6" respectively.

NOTE

If the instrument you are checking does not have the Talk and Listen addresses noted above, check to see if any other instrument has these addresses. If not, then change the instrument addresses to those indicated above. Refer to **Section III, Hardware Programming,** *for instructions on how to change the scanner address. Where multiple instruments are present in the test system, you may want to alter the program and store it on a cassette.*

4. There are three series of displays or printouts where the controller requests a response from the operator. The possible responses and a short explanation of each is listed below.

(a). Controller Printout: "WHICH REED TEST WANTED"

The Operator may respond with the specific test number, then press EXECUTE as shown below:

(Test number) [EXECUTE]

TEST:
1. Low reeds (LOW THERMAL) or A ACTUATOR)
2. High reeds (LOW THERMAL) or B (ACTUATOR)
3. Guard reeds (LOW THERMAL only)
Ø. Finished testing.

(b). Controller displays: "FIRST CHANNEL TO BE TESTED?" or "LAST CHANNEL TO BE TESTED?"

The Operator should respond with the specific channel number. The assemblies are numbered 0-9, 10-19, etc. beginning with the far right assembly as you look at the rear of the instrument. The channel number input should be limited to those channels available on the decade assembly under test.

(Channel Number) [EXECUTE]

(c). Controller displays: "ARE MORE CHANNELS TO BE TESTED?"

The Operator should respond with

[1] [EXECUTE] for yes and [0] [EXECUTE] for NO.

NOTE

Answer yes if you desire to continue testing the same decade assembly.

A complete explanation of all instructions and Operator response is provided in Table 2-2.

5. When the 3495A Verification Program has been completed, insure the tape has been rewound by pressing: [REWIND]

6. To rerun this Verification Test for the next decade assembly, move the Test Fixture to the new decade assembly and repeat the Verification Checks following the Operating instructions.

NOTE

To repeat the Scanner Troubleshooting program for the same decade assembly, just press:

[RUN] [EXECUTE]

7. Remove the Test Fixture and replace with the appropriate Terminal Assembly.

8. If the Verification Checks for the system are complete you may want to reload any Special Function programs that are not already located on File 1 of the 3495A/9830A Cassette. The Special Function programs supplied with the system were loaded earlier in the procedure. To load additional programs, press:

[LOAD] [K] [E] [Y] [ ] [EXECUTE]

File Number

The system is now ready to resume normal operations.

Table 7-3. Controller Instructions and Operator Responses.

The instructions to the operator begin as soon as RUN EXECUTE has been pressed. Refer to the paragraphs below for a discussion of each instruction and the response (if applicable).

a. After the header has been printed the controller will print:

```
THIS PROGRAM TESTS LOW THERMAL OR ACTUATOR RELAYS.  SEE 3050B MANUAL,
OPERATIONAL CHECKS FOR INSTRUCTIONS.

WHICH REED TEST WANTED?  LOW(OR A)=1,HIGH(OR B)=2,GUARD=3,END=0
```

The Operator must respond with numbers 0, 1, 2, or 3 (defined below) then EXECUTE.

TEST:
1 Low reeds (Low Thermal) or A (ACTUATOR)
2 High reeds (Low Thermal) or B (ACTUATOR)
3 Guard reeds (Low Thermal)
0 finished testing

NOTE

The message requesting a specific reed test is printed again after each reed test that is completed.

The input will be tested for a valid number (0 through 3). An incorrect input will cause the controller to display:

INCORRECT INPUT!

The Controller then prints the Reed Test Message again. It will remain in this loop until a valid input is received.

b. The Controller then instructs the Operator to check the setting of the 10 position switch and continue the program operation by printing:

```
CLOSE ALL SW OF 10 POS SW
 PRESS CONT EXECUTE WHEN READY
```

c. The Operator input identifying a specific reed test will then cause the controller to print one of the three printouts shown below.

```
**********LOW (A) REEDS**********

CLOSE SW 1, OPEN 2&3 OF 3 POS SW
 PRESS CONT EXECUTE WHEN READY
```

Table 7-3. Controller Instructions and Operator Responses (Cont'd).

```
**********HIGH (B) REEDS**********

CLOSE SW 2, OPEN 1&3 OF 3 POS SW
 PRESS CONT EXECUTE WHEN READY


**********GUARD REEDS**********

CLOSE SW 3, OPEN 1&2 OF 3 POS SW
 PRESS CONT EXECUTE WHEN READY
```

The printouts identify the reed test selected and proper setting of the 3 positions switch.

d. When the program has been continued, the controller displays the following messages requesting the first and last channel to be tested. LAST CHANNEL TO BE TESTED? FIRST CHANNEL TO BE TESTED? The operator must input a channel number between 0 and 79, then press execute after each message.

NOTE

If the inputs are not in the specified numerical range or if the first channel number is larger than the last channel number, the display will be INCORRECT INPUT! and the controller will repeat the message.

Valid inputs will allow a printout of the Channels under test as shown below.

```
CHANNELS 11 THRU 12.
```

e. During the actual testing of each specific channel, the controller will determine if any of the relays in the channels under test are shorted or resistive. A successful test would cause the program to printout:

```
ALL OKAY.
```

f. If a relay is resistive the program will printout an error message identifying the specific channel containing the relay. The program will continue to cycle through each of the channels until all relays have been tested. An example printout is shown below.

```
***FAILURE***
          CHAN  11 RESISITIVE, SEE RELAY REPLACEMENT PROCEDURE.
```

NOTE

If only resistive relays are identified, skip to Step h.

g. A shorted relay can be identified through the use of the Scanner Troubleshooting program. If a shorted relay is detected during the tests the controller will print:

```
***FAILURE***
        AT LEAST 1 RELAY SHORTED,TAPE LOADING 3495A TROUBLESHOOT
PROGRAM  TO FIND BAD RELAY.  FOLLOW INSTRUCTIONS.
```

1. The troubleshooting program is automatically loaded by the Scanner Verification Check. As soon as the Trouble-shooting program is loaded the program will print:

```
THIS PROGRAM WILL HELP YOU FIND SHORTED RELAY.
FIRST LET'S MAKE A QUICK CHECK.

CHECK RELAY DECADE ASSEMBLY BEING TESTED FOR GOOD CONNECTIONS
ON INTERNAL EDGE CONNECTOR, TERMINAL BLOCK & 3490A CONNECTORS.
(REPEAT STEPS 1 THROUGH 5 OF SCANNER TEST SET-UP PROCEDURE.

PRESS CONT EXECUTE WHEN READY
```

Table 7-3. Controller Instructions and Operator Responses (Cont'd).

2. When the program is continued by the Operator, the controller will retest the channel assembly for a short and print:

```
LET'S SEE IF THAT SOLVED THE PROBLEM.
```

3. If the retest is successful (no shorted relays) the printout will be:

```
ALL RELAYS WILL NOW OPEN.  THE TAPE IS NOW RE-LOADING THE SCANNER
TEST.  RE-RUN TEST FOR SAME REED TO SEE IF ANY OTHER RELAY IS BAD
THEN RUN ANY REMAINING REED TESTS.
```

A failure in the retest will cause the program to print:

```
AT LEAST ONE RELAY STILL SHORTED
WHICH SWITCH OF 3 POSITION SWITCH IS ON?
```

The Operator should respond with the switch position (1, 2, or 3 – EXECUTE) of the 3 position switch. This allows the program to identify the specific reed test that originated the failure.

4. The program will then ask for the first channel number being tested. This identifies the specific decade assembly under test. The printout is shown below:

```
WHAT IS THE NUMBER OF THE FIRST CHANNEL IN THE DECADE BEING TESTED?
(IE., 0,10,20,...)
```

NOTE

The channel numbers are preset at the factory. Beginning at the far right, as you view the rear of the instrument, the assemblies are numbered ØØ, 1Ø, 2Ø, and 3Ø.

5. The program, with the assistance of the Operator, will begin to check each channel. The Controller will instruct the Operator to open and close switches on the Test Fixture to test each channel separately. An indication of the bad channel will be printed as soon as the malfunction occurs. An example of the Controller instructions and the error message for each relay type is shown below.

Printout of Controller Instructions

```
NOW LET'S FIND BAD RELAY BY SUCCESSIVELY ELIMINATING CHANNELS


OPEN SWITCHES 1 THROUGH   1 OF 10 POSITION SWITCH
PRESS CONT EXECUTE WHEN READY

OPEN SWITCES 1 THROUGH   2 OF 10 POSITION SWITCH
PRESS CONT EXECUTE WHEN READY


OPEN SWITCES 1 THROUGH   3 OF 10 POSITION SWITCH
PRESS CONT EXECUTE WHEN READY


OPEN SWITCES 1 THROUGH   4 OF 10 POSITION SWITCH
PRESS CONT EXECUTE WHEN READY


OPEN SWITCES 1 THROUGH   5 OF 10 POSITION SWITCH
PRESS CONT EXECUTE WHEN READY
```

Table 7-3. Controller Instructions and Operator Responses (Cont'd).

```
OPEN SWITCES 1 THROUGH   6 OF 10 POSITION SWITCH
PRESS CONT EXECUTE WHEN READY

OPEN SWITCES 1 THROUGH   7 OF 10 POSITION SWITCH
PRESS CONT EXECUTE WHEN READY

OPEN SWITCES 1 THROUGH   8 OF 10 POSITION SWITCH
PRESS CONT EXECUTE WHEN READY

OPEN SWITCES 1 THROUGH   9 OF 10 POSITION SWITCH
PRESS CONT EXECUTE WHEN READY

OPEN SWITCES 1 THROUGH  10 OF 10 POSITION SWITCH
PRESS CONT EXECUTE WHEN READY
```

Printout of Error Messages

```
THE LOW(OR A) RELAY IN CHANNEL  11 BAD, REPLACE PER RELAY
REPLACEMENT PROCEDURE. THEN PRESS RUN EXECUTE & RE-RUN THIS
PROGRAM TO SEE IF MORE THAN ONE RELAY BAD.

END OF PROGRAM

THE HIGH (OR B) RELAY IN CHANNEL  11 BAD, REPLACE PER RELAY
REPLACEMENT PROCEDURE  THEN PRESS RUN EXECUTE & RE-RUN THIS
PROGRAM TO SEE IF MORE THAN  ONE RELAY BAD.

END OF PROGRAM

THE GUARD RELAY IN CHANNEL  11 BAD, REPLACE PER RELAY REPLACEMENT
PROCEDURE.  THEN PRESS RUN EXECUTE & RE-RUN THIS PROGRAM TO SEE
IF MORE THAN ONE RELAY BAD.

END OF PROGRAM
```

h. When a reed test is completed, the program will ask if the Operator wishes to continue by displaying:

ARE MORE CHANNELS TO BE TESTED?

If the operator responds with a Ø EXECUTE (NO) the program will ask which reed test is desired. An input of 1, 2, or 3 would start the test sequence again (see Step a). A Ø response (END OF TESTING) would generate a printout indicating the successfulness of the Testing and a display of "END OF TEST". See the examples below.

```
***PASSED TEST***

***FAILED TEST***
```

NOTE

A faulty relay(s) (if any) may be replaced following the relay replacement procedure in Appendix A of this Manual.

A response of "1 EXECUTE" (YES) will cause the program to ask for a FIRST and LAST channel number (see Step d).

OR

If all of the switches have been opened and the reading from the Scanner still indicates a resistance reading of less than 12 MΩ, the problem is not in the relays themselves, but in some other portion of the 3495A Scanner or in the 3490A Multimeter. The program will print the following display for this case.

```
ALL RELAYS WILL OPEN,PROBLEM IN OTHER AREA
END OF PROGRAM
```

7-40. Definition of Program Variables.

7-41. Each of the variables used in the Scanner Verification Program is defined below.

C – Channel
C1 – First channel to be tested
C2 – Last channel to be tested
D Reed Test – 1 = Low, 2 = High, 3 = Guard, ∅ = Finished
FNMC – DVM Measurement on Channel C
L FLAG – Failed Test
N FLAG – Reed fails to close (> 1 ohm)
T FLAG – Title has been printed
Y FLAG – More channels are to be tested

7-42. Program Modification.

7-43. The Verification Program can be modified to test a 3495A Scanner with a different address than used in the original program by changing the Listen addresses. You will need your 3495A/9830A Cassette (-hp- Part No. 44195-10001) and also a blank cassette (-hp- Part No. 9162-0050).

NOTE

It is suggested you store your revised program on a cassette for future use. If the cassette is initially completely blank, you should mark the file lengths that will be required first. Then FIND the file before beginning to STORE the program.

7-44. To modify the Verification Program, follow the steps below.

a. Insert the 3495A/9830A Cassette into the cassette transport and close the door.

b. Load the 3495A Verification Check onto the keyboard by pressing.

[SCRATCH] [EXECUTE]

Then

[LOAD] [3] [EXECUTE]

NOTE

The Special Key Function programs should also be loaded into the keyboard if this has not already been done. This may be done by pressing

[LOAD] [K] [E] [Y] [1] [EXECUTE]

Then

[REWIND] [END OF LINE]

c. After the tape has stopped press [REWIND]

d. Obtain a listing of the program by pressing:

[LIST] [EXECUTE]

e. Remove the listing from the printer.

f. Repeat Steps b through e to obtain a listing for the 3495A Scanner Troubleshooting Program located on File 5.

g. Refer to the System Configuration Sheet for the address of the 3495A you are modifying the program for.

h. Make the changes required to edit the program on the printout you just obtained using the information below.

Line 440 Change the Listen address to the new character
CMD"?U)"
└── Listen

Line 1040 Change the Listen address to the new character
CMD"?U)"
└── Listen

3495A SCANNER TROUBLESHOOTING PROGRAM

Line 310 Change the Listen address to the new character
CMD"?U)"
└── Listen

Line 700 Change the Listen address to the new character
CMD"?U)"
└── Listen

i. It will also be necessary to modify the Special Function Program. To obtain a listing, press: [LIST] [SHIFT] [f6]

j. Remove the listing from the printer.

k. Make the changes required to edit the program on the printout you just obtained using the information below.

Line 30 Change the Listen address.
CMD"?)"
└── Listen

NOTE

If the 3490A Multimeter being used to check out the Scanner does not have a Talk and Listen address of "V" and "6", Lines 60 and 110 must also be changed to the new address.

l. Revise each line of the Verification, Troubleshooting, and Special Function programs as indicated below.

NOTE

Since the Troubleshooting and the Special Function programs are already in the Keyboard memory, revise these programs first, then revise the Verification program. Be sure to put the controller in Key Mode first, before attempting to call up program lines for the Special Function program. Key Mode may be entered by pressing:

[FETCH] [f]

└── Specific Key Number

1. Using the editing keys, call up each program line number and revise each line.

2. Insert a cassette with blank files available into the cassette transport.

3. Mark the selected file for 1300 words by pressing:

[F] [I] [N] [D] [ ] [ ] [EXECUTE]

Selected File Number (the two blank keys)

Then

[M] [A] [R] [K] [1] [,] [1] [3] [0] [0] [EXECUTE]

4. Store the revised program on the cassette you just marked by pressing:

[STORE] [ ] [ ] [EXECUTE]

Selected File No. (the two blank keys)

m. You are now ready to test the desired instrument. Simply press:

[RUN] [EXECUTE]

NOTE

Since this is a new program, it will not be listed on the Verification Program Instruction Index. If you desire to have the Instruction Program available in your new cassette, follow the same instructions for program editing and store the revised program in the selected file number.

7-45. TROUBLESHOOTING.

7-46. It is improbable that more than one or two relays will be resistive or shorted at the same time. An occurrence of this type usually means that another problem exists. Typical problems that may cause this condition are listed below.

a. Poor connection of the edge connector between the Decade Assembly and Scanner. To correct this first remove the Test Fixture then the Decade Assembly in question. Reinsert the assembly. Make sure that it is well seated into the Scanner.

b. Poor connection between the Decade Assembly and the Test Fixture. Remove the Test Fixture and reinsert.

NOTE

The Actuator assembly is more likely to have this condition.

c. Poor connection between the Test Fixture Plug and the female connector on the rear of the 3490A. Check the tightening ring on the plug to insure it is turned fully clockwise. The plug may have to be removed and reconnected.

d. FRONT/REAR input switch on the front panel of the 3490A set to FRONT. Set the switch to REAR.

e. Addressing Wrong Decade. Check to see that the Operator input of the channel number during the Verification Check corresponds to the decade under test.

f. Talk and Listen addresses incorrect. Refer to the System Configuration Sheet to insure the address of the instruments used in the Verification Check corresponds to those used in the program.

7-47. Operator Troubleshooting.

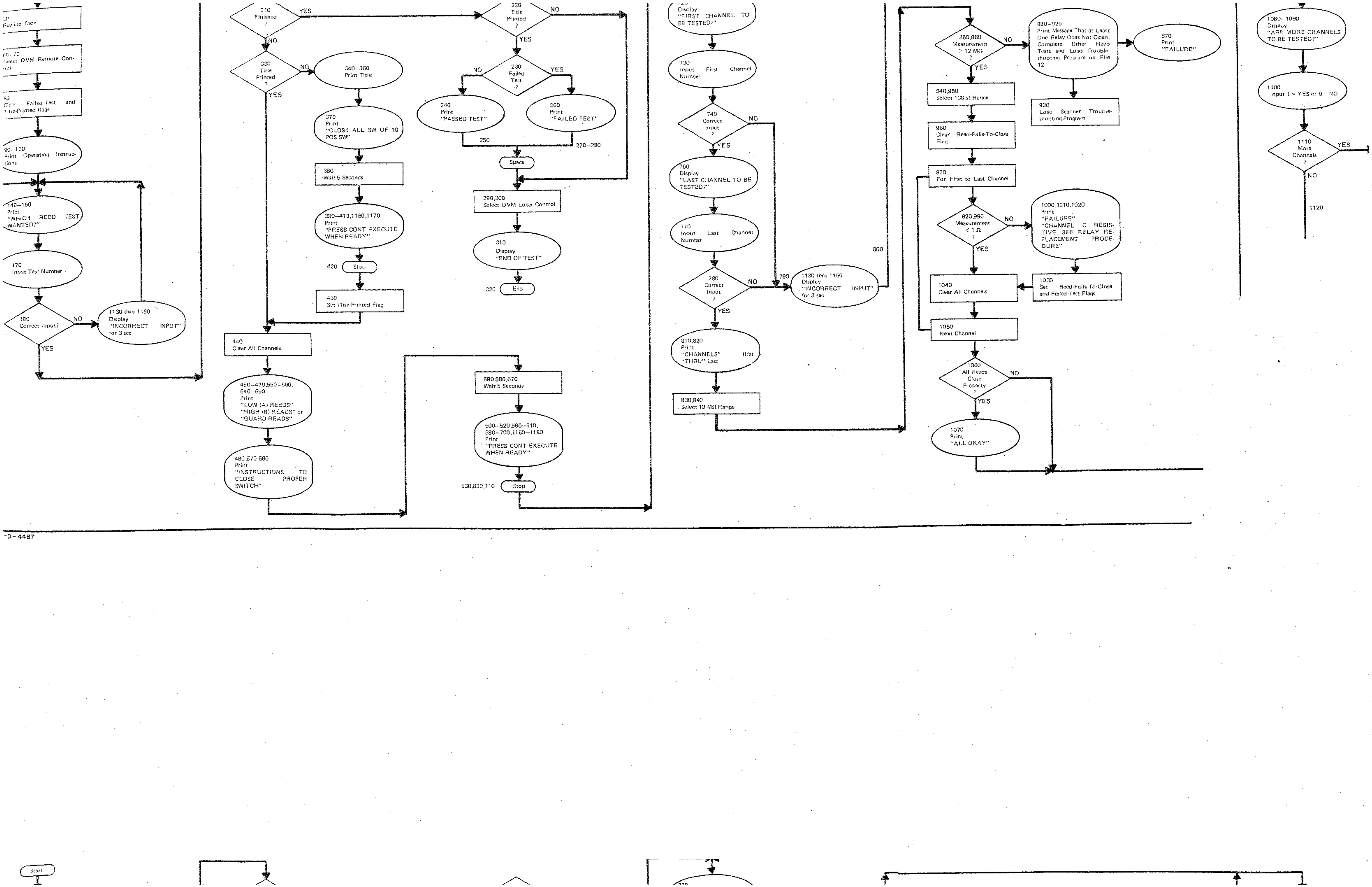
7-48. The following paragraphs cover general operator troubleshooting hints and procedures for the operator to perform when the verification program stops or hangs up during execution. The procedures are given in a suggested order of performance.

7-49. Troubleshooting Hints and Procedures. Follow Steps a through c, paying attention to the seven troubleshooting hints that follow.

a. If the controller or 3495A under test does not respond after approximately 1 minute during program execution, the system has become hung up, i.e., it has stopped on some program line and will not advance any further. To regain control of the controller, press STOP. A line number will appear on the display. To see the program line that the controller has stopped on, press:

[FETCH] (Line Number) - 1 [EXECUTE]

If you have modified the verification program for another address or for some other reason, the program may then be


20
Rewind Tape
60–70
Select DVM Remote Control
80
Clear Failed-Test and Title-Printed flags
90–130
Print Operating Instructions
140–160
Print
"WHICH REED TEST WANTED?"
170
Input Test Number
180
Correct Input?
NO
YES
1130 thru 1150
Display
"INCORRECT INPUT"
for 3 sec
210
Finished
?
YES
NO
330
Title
Printed
?
NO
YES
340–360
Print Title
370
Print
"CLOSE ALL SW OF 10 POS SW"
380
Wait 5 Seconds
390–410,1160,1170
Print
"PRESS CONT EXECUTE WHEN READY"
420
Stop
430
Set Title-Printed Flag
440
Clear All Channels
450–470,550–560,
640–650
Print
"LOW (A) REEDS"
"HIGH (B) READS" or
"GUARD READS"
480,570,660
Print
"INSTRUCTIONS TO CLOSE PROPER SWITCH"
220
Title
Printed
?
NO
YES
230
Failed
Test
?
NO
YES
240
Print
"PASSED TEST"
260
Print
"FAILED TEST"
250
270–280
Space
290,300
Select DVM Local Control
310
Display
"END OF TEST"
320
End
590,580,670
Wait 5 Seconds
500–520,590–610,
680–700,1160–1180
Print
"PRESS CONT EXECUTE WHEN READY"
530,620,710
Stop
Display
"FIRST CHANNEL TO BE TESTED?"
730
Input First Channel Number
740
Correct
Input
?
NO
YES
760
Display
"LAST CHANNEL TO BE TESTED?"
770
Input Last Channel Number
780
Correct
Input
?
NO
YES
790
1130 thru 1150
Display
"INCORRECT INPUT"
for 3 sec
800
810,820
Print
"CHANNELS" first
"THRU" Last
830,840
Select 10 MΩ Range
850,860
Measurement
> 12 MΩ
?
NO
YES
880–920
Print Message That at Least One Relay Does Not Open, Complete Other Reed Tests and Load Trouble-shooting Program on File 12
870
Print
"FAILURE"
930
Load Scanner Trouble-shooting Program
940,950
Select 100 Ω Range
960
Clear Reed-Fails-To-Close Flag
970
For First to Last Channel
920,990
Measurement
< 1 Ω
?
NO
YES
1000,1010,1020
Print
"FAILURE"
"CHANNEL C RESISTIVE, SEE RELAY REPLACEMENT PROCEDURE"
1030
Set Reed-Fails-To-Close and Failed-Test Flags
1040
Clear All Channels
1050
Next Channel
1060
All Reeds
Close
Properly
?
NO
YES
1070
Print
"ALL OKAY"
1080–1090
Display
"ARE MORE CHANNELS TO BE TESTED?"
1100
Input 1 = YES or 0 = NO
1110
More
Channels
?
YES
NO
1120
Start

D-4487

Table 7-4. T List of 3495A/9830A Cassette.

File No.	File Type	Words/ File	Words Used	Start Line Number	End Line Number	Common Area	
0	0	25	0	0	0	0 *	
1	4	1000	530	0	0	0	Special Function Keys
2	0	25	0	0	0	0 *	
3	3	1300	1112	20	1170	0	3495A Scanner Verification
4	0	25	0	0	0	0 *	
5	3	1300	1124	100	900	0	3495A Troubleshooting
6	0	25	0	0	0	0 *	

*Indicates Blank File

the source of the problem. Often it is an incorrect address which can be corrected and the Verification Check rerun. There may be problems with the HP-IB Cables, Instrument I/O, or the I/O Card. Refer to Step b if the suspected problem is with the HP-IB.

b. Connect only the 3495A under test to the controller via a single HP–IB Cable. Then rerun the Verification Chuck (ie., "recable").

NOTE

This will help to determine the possibility of another instrument or cable malfunctioning and creating a problem with the instrument under test.

c. Failure of the check in Step a indicates a possible malfunctioning of the HP–IB Cable, HP–IB I/O Card, or the Controller. Replace the HP–IB Cable and rerun the Verification Check for the original under test. If a component or instrument is malfunctioning, or if the problem cannot be isolated, contact your local -hp- Field Office for assistance.

NOTE

It is helpful to jot down each of the things you have done to determine the problem. This prevents repeating something already done.

1. All instruments ON and power applied.
2. Cassette transport door closed.
3. Printer has paper.
4. Talk and Listen addresses used by program same as instrument under test.
5. HP–IB cable connectors completely free of all foreign material.
6. HP–IB cables securely connected.
7. No more than two (2) meters HP–IB cable per device in the test set-up.

7-50. Scanner Test Fixture – Theory of Operation.

7-51. The scanner test fixture serves two functions:

a. Selection of the reed test to be run—either Low, High or Guard for Low Thermal Assemblies or A or B for Activator Assemblies.

b. Isolation of shorted relays.

Refer to the schematic of the scanner test fixture shown in Figure 7-3 for the following discussion.

7-52. When the Scanner Test Program is being run, all switches in the 10 position, channel selector switches should be closed. The Reed Selector switch corresponding to the reed test to be run is closed; the other two switches are open.

7-53. The Scanner Test Program first opens (clears) all relays in the scanner. If any relay of the reed type being tested is shorted, the 3490A DVM will read a short. Since the relays of all the channels in the decade are connected in parallel, it is only possible to say that one of the relays of the reed type under test is shorted. To determine which relay is shorted, the Scanner Troubleshooting Program must be run.

7-54. The Scanner Troubleshooting Program instructs the operator to begin opening channel selector switches sequentially. When the channel selector switch for the shorted relay is opened, the 3490A DVM will read an open and the channel number of the defective relay is printed out. (The defective relay will be the last one removed from the circuit before the DVM read an open.)

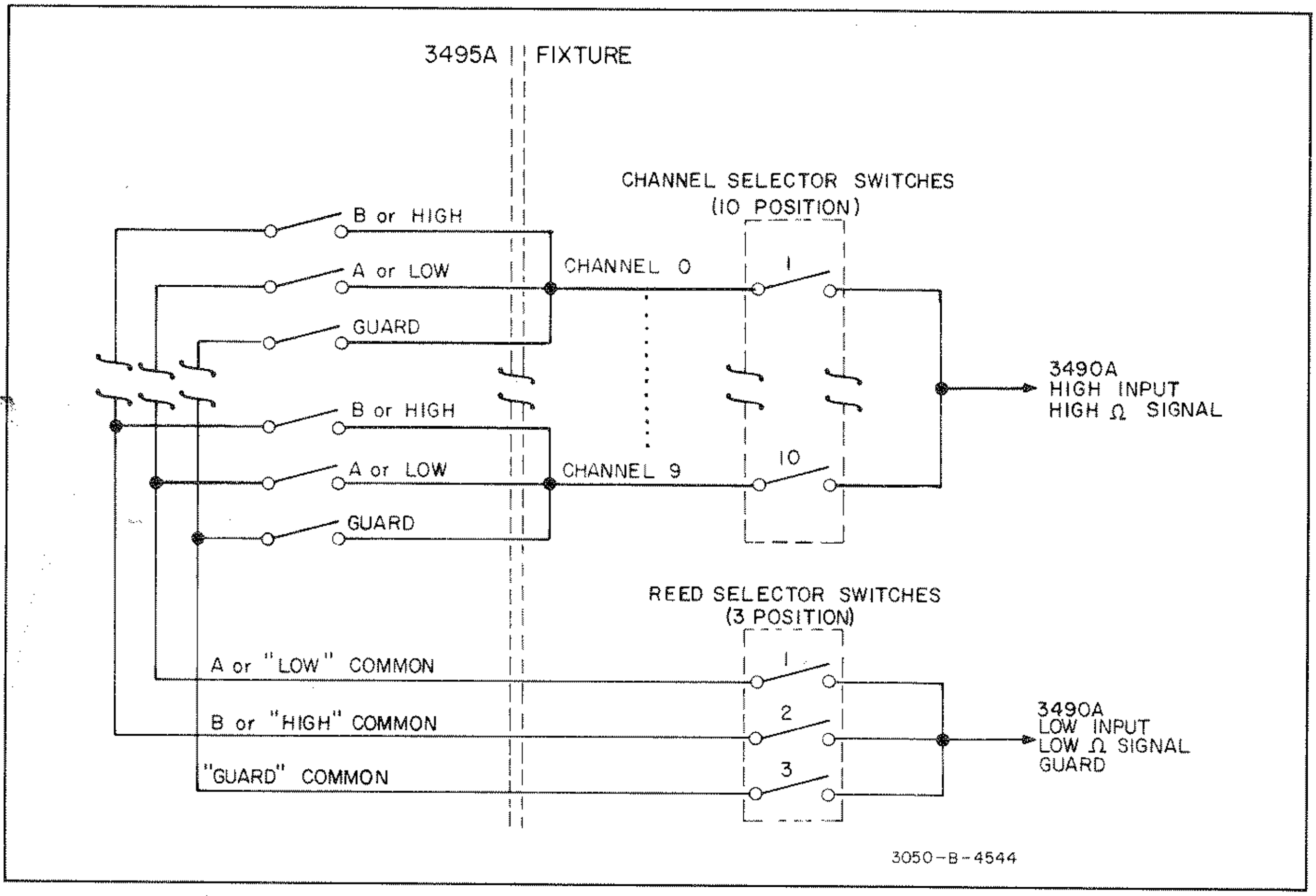


Figure 7-3. Scanner Test Fixture.

7-55. OPERATIONAL VERIFICATION CHECK: 9825A CALCULATOR.

7-56. Description.

7-57. The Scanner verification program checks each channel assembly separately in the Scanner under test. Each relay in the channel under test (High, Low, and Guard for the Low Thermal assemblies and for actuator assemblies A and B) is tested by the Scanner Verification Check. If a defective relay is found, the program will print out an error message indicating the defective relay channel number and the type of defect (resistive or shorted).

7-58. To determine if a relay is defective, the program selects the DVM OHMS function and measures the input resistance of the LOW THERMAL or ACTUATOR CHANNELS. This determines if each relay in a particular channel does not open (less than 1 megohm) or does not close (greater than 1 ohm).

7-59. In the case of a resistive relay, as soon as the defect is detected the error message is printed.

7-60. If one or more relays are shorted, the program will automatically load in the Scanner troubleshooting program first. This program will instruct the Operator to open certain switches on the Scanner Test Fixture until the shorted relay(s) is found. The program will then output the error message on the printer. Any type of defective relay may be replaced easily and simply by following the Scanner Repair procedures found in Service Groups B and C of this manual.

NOTE

The Verification Check program flowchart may be found on Figure 7-5.

7-61. EQUIPMENT REQUIRED.

7-62. To run the Scanner Verification Check you will need the -hp- Model 9825A Calculator, -hp- Model 3495A Scanner, -hp- Model 3455A DVM, 3495A/9825A Test Cassette (-hp- Part No. 44195-10002), Low Thermal and/or Actuator, Scanner Test Fixture (-hp- Part No. 03495-67901 and -hp- Part No. 03495-66522, respectively), and the Fixture Cable Assembly (-hp- Part No. 03052-26501).

7-63. OPERATING INSTRUCTIONS.

7-64. The Operating Instructions for the Scanner Verification program are divided into two main areas—Equipment Setup and Verification Program Instructions.

a. Equipment Setup. In order to run the Scanner Verification Program, the Low Thermal or Actuator Test Fixture and Fixture Cable must be connected to the channel assembly under test and to the 3455A DVM. Refer to the steps below for the proper procedure.

1. Turn the 3455A DVM and 3495A Scanner Power switches to OFF.

2. Open the relay access panel on the rear of the Scanner by removing the two retaining screws.

NOTE

Refer to the Relay Replacement Procedures, Service Groups B and C, for step-by-step instructions on removal of the rear access panel and terminal assembly.

3. Remove the Terminal assembly from the Decade Channel assembly located on the far right as viewed from the rear of the instrument.

4. Insert the Test Fixture into the appropriate Decade channel assembly. Make sure the Test Fixture connector is making a good electrical connection.

NOTE

The Low Thermal Assembly Test Fixture is -hp- Part No. 03495-67901, the Actuator Assembly Test Fixture is -hp- Part No. 03495-66522 and the Fixture Cable Assembly is -hp- Part No. 03052-26501. If you are not sure which assembly is in the location you have selected, you may determine the correct fixture by matching the connectors of the Fixture and the Decade Channel Assembly.

5. Connect the Cinch Connector of the Test Fixture Cable (-hp- Part No. 03052-26501) to the rear of the 3455A DVM. Refer to Figure 7-4 for a wiring diagram.

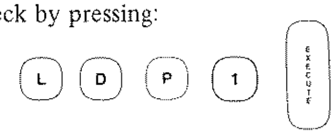
NOTE

Insure the FRONT/REAR switch on the 3455A is set to REAR.

6. Set the DVM and Scanner POWER switches to ON and insert the 3495A/9825A Test Cassette (-hp- Part No. 44195-10002) into the Controller tape transport.

b. Verification Program Instructions.

1. Load the 3495A Scanner Operational Verification Check by pressing:



2. Follow the instructions listed by the printer. The 3495A Scanner Verification Program and the Scanner Troubleshooting program are written for 3495A Scanner select codes 709, 710, 711, 712 and a 3455A DVM select code 722.

NOTE

If the instrument you are checking does not have one of the Select Codes (Talk and Listen address) noted above, check to see if any other instrument has these addresses. If not, then change the instrument address to one of those indicated above. Refer to **Section III, Hardware Programming,** *for instructions on how to change the instrument address. Step 3 also contains important information on multiple scanner addresses.*

3. Multiple Scanners. The Scanner Verification program may check up to eight scanners simulta-

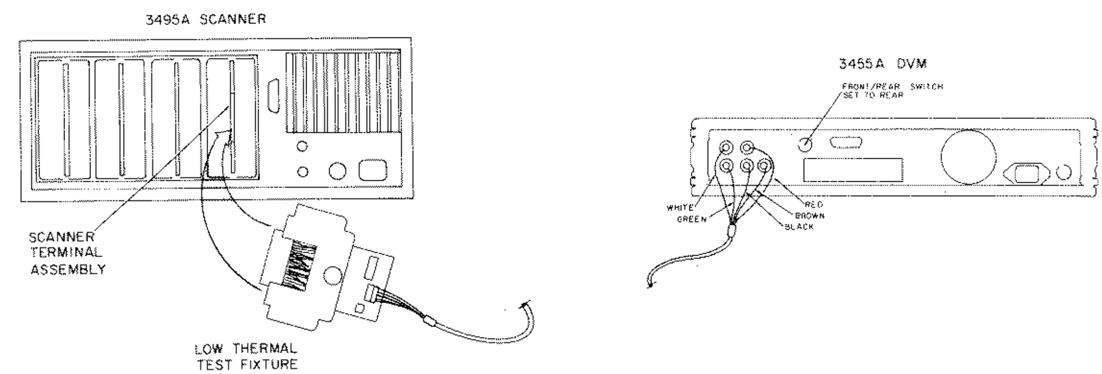


Figure 7-4. Scanner Verification Program Wiring.

neously. The following conditions must be adhered to for the check to perform properly.

(a) There can only be two scanners per select code.

(b) The first scanners must have the 709 select code. Select Codes 710, 711, 712 must be used in order (2 scanners each except for the last select code used).

(c) 1 or 2 scanners may use the last appropriate select code.

(d) Each set of scanners must have internal channel addresses set up for 0 through 39 and 40 through 79, respectively.

4. There are three series of displays or printouts where the controller requests a response from the operator. The possible responses and a short explanation of each is listed below.

(a) Controller display: "WHICH REED TEST WANTED?"

The operator must respond with the specific test number, then press CONTINUE as shown below:

(Test Number) [CONTINUE]

Test:

1 Low reeds (LOW THERMAL) or A (A CHANNEL ACTUATOR).

2 High reeds (LOW THERMAL)or B (B CHANNEL ACTUATOR).

3 Guard reeds (LOW THERMAL only).

0 Finished testing.

(b) Controller displays: "FIRST CHANNEL TO BE TESTED?" or "LAST CHANNEL TO BE TESTED?"

The operator should respond with the specific channel number. The assemblies are numbered 0-9, 10-19, etc. beginning with the far right assembly as you look at the rear of the instrument. The channel number input should be limited to those channels available on the decade assembly under test.

(Channel Number)

NOTE

MULTIPLE SCANNERS. If more than one scanner is included in your system, the scanners and software are configured to call the channels beginning at channel number 0 to the maximum channel number in your system. See the example below.

Select Code 709		*Select Code 710*	
SCN1	*SCN2*	*SCN3*	*SCN4*
0-39	*40-79*	*80-119*	*120-159*

Select Code 711		*Select Code 712*	
SCN5	*SCN6*	*SCN7*	*SCN8*
160-199	*200-239*	*240-279*	*280-319*

(c) Controller displays: "MORE CHANNELS FOR TEST, Y/N (1/0)? The operator should respond with

[1] [CONTINUE] for YES and [0] [CONTINUE] for NO

NOTE

Answer yes if you desire to continue testing the same decade assembly.

A complete explanation of all instructions and operator response is provided in Table 7-5.

5. If you desire to run the Verification Checks for other instruments, refer to the appropriate paragraph for the specific instrument.

6. To rerun this Verification Test for the next decade assembly, move the Test Fixture to the new decade assembly (see Equipment Setup) and repeat the Verification Checks following the Operating instructions.

NOTE

To repeat the Scanner Verification Program for the same decade assembly, just press: [RUN]

7. Remove the Test Fixture and replace with the appropriate Terminal Assembly. The system is now ready to resume normal operations.

7-65. DEFINITIONS OF PROGRAM VARIABLES.

7-66. The 3495A Scanner Operational Verification Check uses numerous variables when running the program. The

variable definition and line location of the variable are shown below:

A Error flag, when set to "1" indicates a resistive relay.
B Stores first channel number to be tested, operator defined.
C Current channel number under test.
D Current REED Test, operator defined.
E Error flag, when set to "1" indicates a shorted relay.
J Channel counter for Scanner Troubleshooting Subroutine.
K Stores current channel number for Scanner Troubleshooting Subroutine.
M Stores value of DVM reading.
R Contains intermediate calculation for finding Variable K.
S Stores last channel number to be tested, operator defined.

7-67. Locations.

7-68. The locations shown below represent all possible line numbers where each variable may be found. In cases where the letter representing the variable is used as text, that location will also be listed.

```
A    80   82   89
90   91
B    54   55   55
60   63   78   118
C    78   78   80
81
D    38   39   40
40   42   45   45
45   45   45   79
127  129
E    68   69   90
106  108  109
J    118  118  120
123
K    118  118  128
130  131
M    67   66   78
79   101  108  121
122
R    118  118
S    57   58   58
60   63   78
Y    88   89
```

7-69. TROUBLESHOOTING.

7-70. It is improbable that more than one or two relays will be resistive or shorted at the same time. An occurrence of this type usually means that another problem exists. Typical problems that may cause this condition are listed below. Also refer to the Operator Troubleshooting in this section.

a. Poor connection of the edge connector between the Decade Assembly and Scanner. To correct this first remove the Test Fixture then the Decade Assembly in question. Reinsert the assembly. Make sure that it is well seated into the Scanner.

b. Poor connection between the Decade Assembly and the Test Fixture. Remove the Test Fixture and reinsert.

NOTE

The Actuator assembly is more likely to have this condition.

c. Poor connection between the Test Fixture Cable and the banana plugs on the rear of the DVM.

d. FRONT/REAR input switch on the rear panel of the 3455A DVM set to FRONT. Set the switch to REAR.

e. Addressing Wrong Decade. Check to see that the Operator input of the channel number during the Verification Check corresponds to the decade under test.

f. Select Codes incorrect. Refer to the System Configuration Sheet to insure the address of the instruments used in the Verification Check corresponds to those used in the program.

g. If the scanner will not respond to Bus signals, press the (RESET) key to clear the Bus. Rerun the program.

Table 7-5. Controller Instructions and Operator Responses.

The instructions to the operator begin as soon as RUN has been pressed. Refer to the paragraphs below for a discussion of each instruction and the response (if applicable).

a. After the header has been printed, the controller will print:

```
This program
tests Low
Thermal or
Actuator Relays.

Read the
instructions in
Oper.& Prog.
Manual, Vol IA,
    before
proceeding then
PRESS CONTINUE

NOTE:
When input
requested,PRESS
NUMBER (Pos.
Whole NO.)
then CONTINUE.
```

At the end of the printout, the controller will display:

PRESS CONTINUE when ready

The operator should press the CONTINUE key when ready to begin the program.

b. The calculator will begin the test by printing:

```
LOW(orA)=1
HIGH(orB)=2
GUARD=3
END TEST=0
```

The display will also read: Which REED TEST wanted?

The operator must respond with numbers 0, 1, 2 or 3 (defined below), then CONTINUE.

TEST: 1 Low reeds (Low Thermal) or A (ACTUATOR)
2 High reeds (Low Thermal) or B (ACTUATOR)
3 Guard reeds (Low Thermal)
0 finished testing

NOTE

The message requesting a specific reed test is printed again after each reed test that is completed.

The input will be tested for a valid number (0 through 3). An incorrect input will cause the controller to display:

INCORRECT INPUT!

The Controller then prints the Reed Test Message again. It will remain in this loop until a valid input is received.

c. The Controller then prints the test selected and instructs the operator to check the setting of the 10 position switch by printing:

```
REED TEST 1
    SELECTED
CLOSE all Switch
of 10 POS.
Switch.

REED TEST 2
    SELECTED
CLOSE all Switch
of 10 POS.
Switch.

REED TEST 3
    SELECTED
CLOSE all Switch
of 10 POS.
Switch.
```

NOTE

If Test 0 is selected, the program will terminate. The Controller will dsp: END OF TEST and print:

```
TEST COMPLETE
```

When the switches have been set, the operator is asked to continue the program from the display:

PRESS CONTINUE when ready

d. The operator input identifying a specific reed test will then cause the controller to print one of the three printouts shown below.

```
**LOW(A) REEDS**

CLOSE Switch 1,
OPEN 2 & 3,
of 3 POS Switch

**HIGH(B) REEDS*

CLOSE Switch 2,
OPEN 1 & 3
of 3 POS. Switch
```

Table 7-5. Controller Instructions and Operator Responses (Cont'd).

```
**GUARD REEDS**

CLOSE Switch 3,
OPEN 1 & 2,
of 3 POS. Switch
```

Insure that the 3 position switch is set properly before continuing.

When the switches have been set, the Operator is asked to continue the program from the display:

Press CONTINUE when ready.

e. When the program has been continued, the controller displays the following messages requesting the first and last channel to be tested. First CHANNEL to be TESTED? Last CHANNEL to be TESTED? The operator must input a channel number between 0 and 319, then press execute after each message.

NOTE

If the inputs are not in the specified numerical range or if the first channel number is larger than the last channel number, the display will be INCORRECT INPUT! and the controller will repeat the message.

Valid inputs will allow a printout of the test number and Channels under test as shown below.

```
TEST #1
Channels  0
     Thru  9
will be tested
for resistance
greater  than
1MEG.
```

The display will also indicate "TEST IN PROGRESS".

f. During the actual testing of each specific channel, the controller will determine if any of the relays in the channels under test are shorted. A successful test would cause the program to print out:

```
TEST #1 OK
```

The program will then sequence to Test No. 2 (refer to Step j for Test No. 2).

g. A shorted relay can be identified through the use of the Scanner Troubleshooting program. If a shorted relay is detected during the tests, the controller will print:

```
****FAILURE****

At least 1 Relay
SHORTED

Follow
    Instructions
```

```
****************

This subroutine
will help you to
isolate the
shorted relay.
First let's make
a hardware
check.

Check the relay
decade assembly
being tested for
good connection
on Internal Edge
Connector,
Terminal block &
3455A Connectors
```

The program will wait until the operator has finished reading the instruction. The display will hold; PRESS CONTINUE when ready. The operator can then press and the program will retest the Scanner Channels and display "TEST in progress" and print:

```
Let's see if
that solved the
problem.
```

h. If the Retest fails the controller will print additional instructions for the troubleshooting program operation as shown below.

The controller will display:

"At least one relay still shorted" then "Instructions →" and print:

```
Let's find the
Bad relay by
successively
eliminating
channels.

Open switches 1
through 1of 10
POS switch
```

The program will wait for the Operator to accomplish the instruction by stopping and displaying:

PRESS CONTINUE when ready

The program will check each channel in succession until the bad relay is found. When a bad relay is found, the controller will print: (Channel number is the variable)

Table 7-5. Controller Instructions and Operator Responses (Cont'd).

```
Low relay in
Channel  1
is bad.

Replace per
Relay
Replacement
Procedure. Then;
PRESS RUN;
the program will
reset and test
the Scanner to
see if more than
one relay is bad

TEST COMPLETE
```

If the program does not find a bad relay, then it will print out:

```
All relays will
open problem
located in
other area.
TEST COMPLETE
```

The operator should refer to the Scanner Troubleshooting paragraphs before proceeding.

i. A successful retest will cause the program to branch back to the first of the program, rerun the test to insure that the relays under test are not shorted, and then continue with any remaining REED tests. The printout of the instructions is shown below.

```
All relays will
now open. The
program will
rerun the
Scanner Test
for the same
Reed;to see
if any other
Relay is Bad.
When this Reed
Test is complete
run any REED
```

```
Tests remaining.
```

j. Test No. 2 will test the relays for their closed resistance. The heading and instructions are shown below.

```
TEST #2
Selected Chan-
nels will be
Tested for resi-
stance less
than 1 ohm
(low thermal)
or 106 ohms
(actuator).
```

If the Test measurements were within the programmed limits, the controller will print:

```
TEST #2 OK
```

The controller will print out any channels that appear resistive. After the resistive channel numbers have been printed out, additional instructions are printed as shown below.

```
***FAILURE***

Channel  0
      RESISTIVE

See 3052A OPER.
PROGRAM Manual
(Vol IA)
for Replacement
Procedures
```

After both Test No. 1 and Test No. 2 have been completed for the selected channels, the controller will allow additional channels or a retest of certain channels by displaying: More Channels for Test, Y/N (1/0)?

A "1" response will cause the program to recycle to the channel request and retest the new channels.

A "0" response will recycle the program to the reed test selection. The remaining reeds may be tested or the program may be aborted by selecting REED TEST 0 (END OF TEST) selection.

If "0" is selected the controller will display: END OF TEST

and print:

```
TEST COMPLETE
```

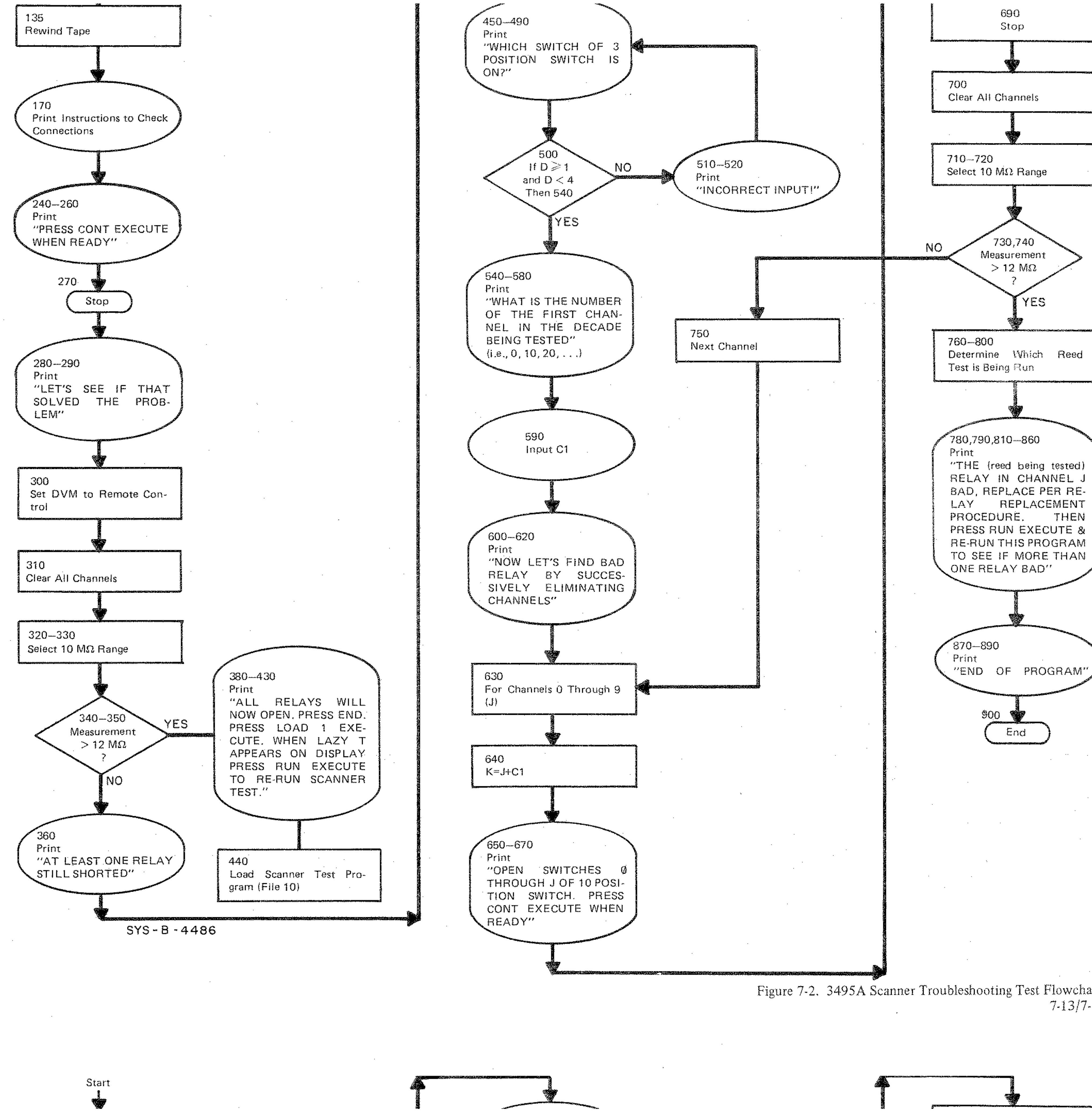


Figure 7-2. 3495A Scanner Troubleshooting Test Flowchart.

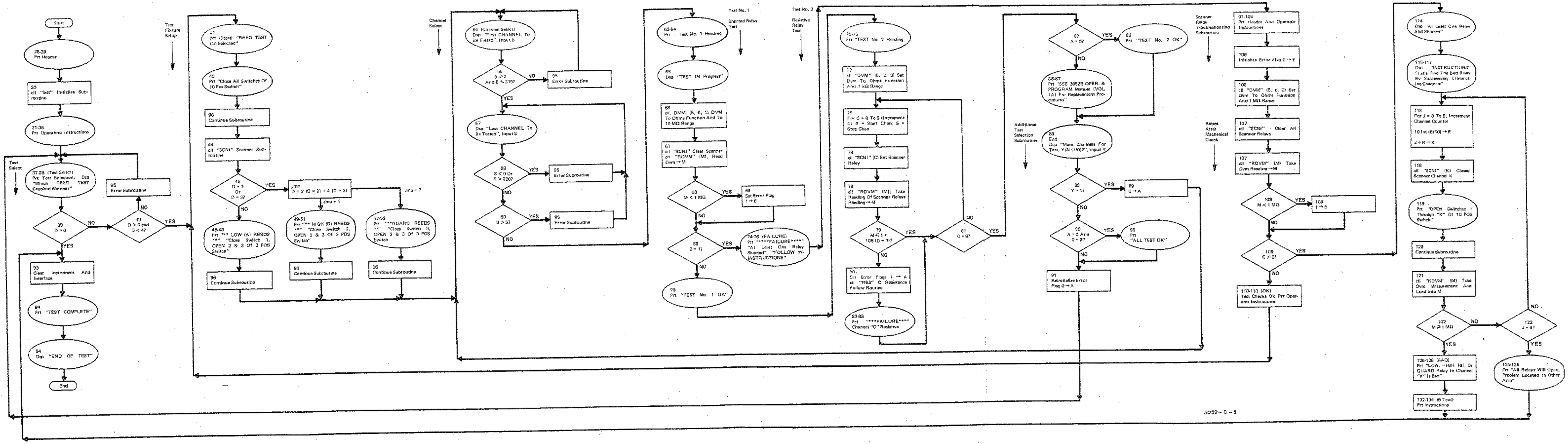


Figure 7-5. 3495A Scanner Verification Program Flowchart.

7-71. PC BOARD CLEANING.

7-72. Some 3495A printed circuit boards require clean handling techniques to preserve their high impedance characteristics. Service procedures on these boards can leave them contaminated with dirt, oil, solder flux, or fingerprints.

7-73. Recovering the original impedance qualities on a contaminated board requires a thorough board cleaning and recoating process. The following method can be used for cleaning PC boards and then recoating the repaired area on the board with a dry film coating.

a. Items needed are:

1. Conventional dishwasher

2. Detergent (one of the following)

(a) Triton CF-54 or CF-76 low foam industrial liquid detergent; available in 5 gallon (45 lb.) containers from Central Solvents, 31702 Hayman Street, Hayward, CA 94544.

NOTE

The Triton products are low foaming and non-ionic. For this application use a dilution factor of 0.1%. CF-54 is more general purpose whereas CF-76 is recommended only for dishwashers.

(b) Alco-Zyme Enzyme Detergent. This is a detergent used in hospitals to clean surgical tools. Available from Scientific Products, 150 Jefferson Drive, Menlo Park, CA 94025.

NOTE

Alco-Zyme is a recommended second choice but be careful, it is a high foaming detergent. If you use too much in the dishwasher you could be inundated with a mountain of suds.

(c) Calgonite dishwasher detergent (if none of the above are available.)

NOTE

The problem with Calgonite is that if improperly rinsed from the PC board, it can leave an electrically conductive film, especially in hard to rinse areas like relays.

3. Distilled water.

4. Cotton gloves, -hp- Part No. 8650-0015.

5. Switch Lubricant -hp- Part No. 5060-6086.

6. Dry Film coating (one of the following).

(a) Dry Film 88 (General Electric) -hp- Part No. 6010-0142.

(b) KENCO #811 Circuit Coat.

(c) KRYLON Acrylic or Dow Corning #991.

(d) scotchgard (if none of the above are available).

NOTE

Make certain that you perform the wash, rinse, and dry cycles continuously. The boards should not be allowed to dry between wash and rinse cycles.

7. After the board has been repaired, remove all assemblies that may be damaged by water and 150°F temperatures (e.g., LED displays, batteries, etc.).

8. Set the water temperature for at least 150°F. Run the empty dishwasher with soap through one cycle to remove any residue.

NOTE

For Triton, use 1/2 oz. (4 tsp.) per wash. For Alco-Zyme, use 1/16 tsp. per wash. For Calgonite, follow directions on the box.

9. Place the boards on their edges on the top rack.

10. Run the dishwasher through the wash cycle only. Use the amount of detergent recommended in the note in step 8. Don't allow the boards to dry before rinsing in the next step.

11. The last rinse cycle should be completed with pre-heated distilled water if at all possible. To accomplish this, shut off the water supply before the final rinse cycle begins. After the rinse water has been pumped out, turn off the washer (usually just opening the door does this), open the door and pour the pre-heated distilled water into the bottom of the washer. Note that if too much Alco-Zyme is used, several rinses may be necessary.

12. If an oven is available, dry the boards in an upright position at 150°F for 3 hours. Otherwise, use the dry cycle on the dishwasher twice.

13. After drying, and while the board is still warm, coat the repaired areas with one of the recommended dry film products.

NOTE

Make certain that you wear cotton gloves when handling the boards.

7-74. ABBREVIATIONS AND SCHEMATIC SYMBOLS.

7-75. Table 7-6 and Figure 7-6 list the abbreviations and symbols used throughout the service section of this manual.

Table 7-6. Abbreviations.

ASCII	American Standard Code for Information Interchange	NDAC	Data Not Accepted
ATN	Attention	NRDGS	Number of Readings
CLK	Clock	NRFD	Not Ready For Data
DAV	Data Valid	PA	Program Address
DCØ—6	Direct Control Ø—6	PROM	Programmable Read-Only-Memory
DIO	Data Input Out	RAM	Random Access Memory
DSXX	Device Select (Non R/W)	REF	Reference
EOI	End or Identify	REN	Remote Enable
EXT	External	ROM	Read-Only-Memory
FF	Flip-Flop	R/W	Read/Write (Low Read)
GND	Ground	SA	Signature Analysis
HP—IB	Hewlett-Packard Interface Bus	SAXX	Signature Analysis Test
IFC	Interface Clear	SG	Service Group
INT ACK	Interrupt Acknowledge	SEC	Second
INT ENA	Interrupt Enable	TRIG	Trigger
INT REQ	Interrupt Request		

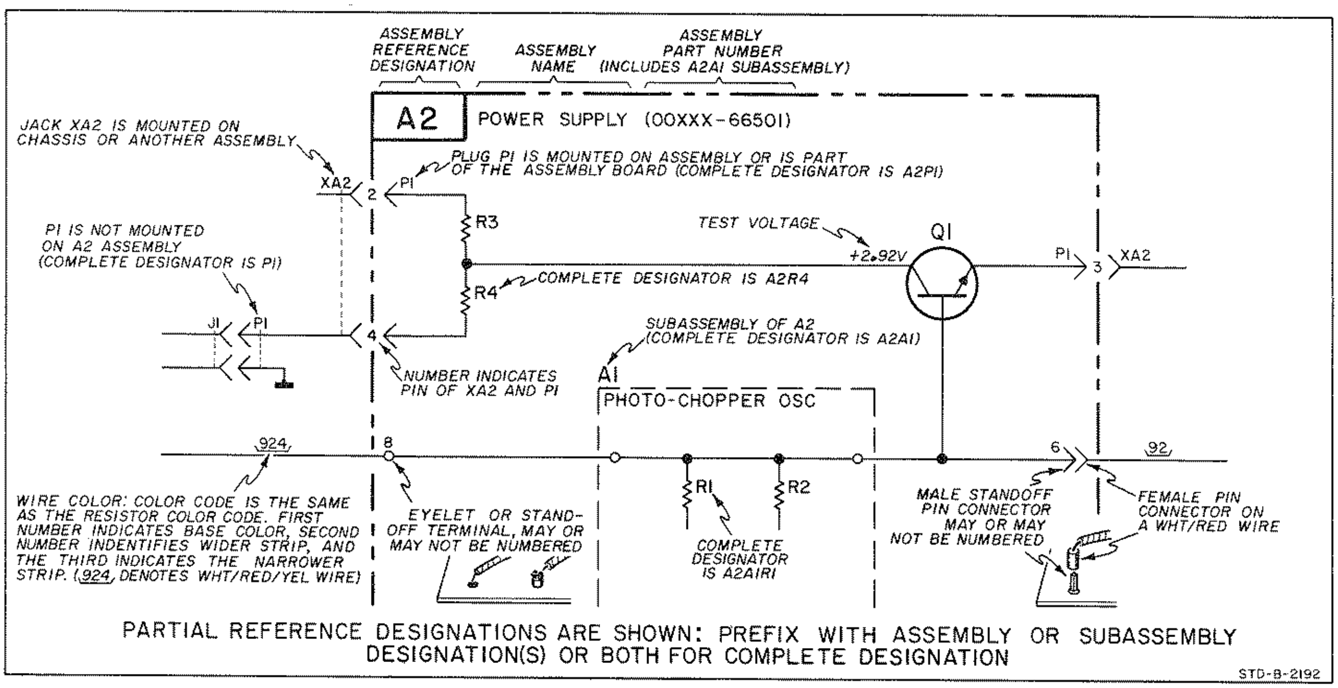


Figure 7-6. Reference Designations and Schematic Symbols.

GENERAL SCHEMATIC NOTES

1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN. PREFIX WITH ASSEMBLY OR SUBASSEMBLY DESIGNATION(S) OR BOTH FOR COMPLETE DESIGNATION.

2. COMPONENT VALUES ARE SHOWN AS FOLLOWS UNLESS OTHERWISE NOTED.
   RESISTANCE IN OHMS
   CAPACITANCE IN MICROFARADS
   INDUCTANCE IN MILLIHENRIES

3. DENOTES EARTH GROUND. USED FOR TERMINALS WITH NO LESS THAN A NO. 18 GAUGE WIRE CONNECTED BETWEEN TERMINAL AND EARTH GROUND TERMINAL OR AC POWER RECEPTACLE.

4. DENOTES FRAME GROUND. USED FOR TERMINALS WHICH ARE PERMANENTLY CONNECTED WITHIN APPROXIMATELY 0.1 OHM OF EARTH GROUND.

5. DENOTES GROUND ON PRINTED CIRCUIT ASSEMBLY. (PERMANENTLY CONNECTED TO FRAME GROUND).

6. DENOTES ASSEMBLY.

7. DENOTES MAIN SIGNAL PATH.

8. DENOTES SCREWDRIVER ADJUST.

9. DENOTES SECOND APPEARANCE OF A CONNECTOR PIN.

10. 924 DENOTES WIRE COLOR: COLOR CODE SAME AS RESISTOR COLOR CODE. FIRST NUMBER IDENTIFIES BASE COLOR, SECOND NUMBER IDENTIFIES WIDER STRIP, THIRD NUMBER IDENTIFIES NARROWER STRIP, (e.g. = WHITE, RED, YELLOW.)

11. ALL RELAYS ARE SHOWN DEENERGIZED.

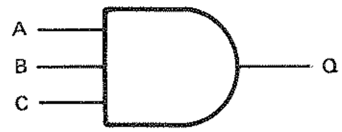
12. DENOTES FRONT PANEL MARKING.

EACH GATE IS INDIVIDUALLY DEPICTED BY ITS LOGICALLY EQUIVALENT "OR" OR "AND" SYMBOL ACCORDING TO ITS USE IN THE CIRCUIT. NOTICE THE LOGICAL EQUIVALENCE OF THE "NOR" GATE AND THE "AND" GATE WITH INVERTED INPUTS, AND OF THE "NAND" GATE AND THE "OR" GATE WITH INVERTED INPUTS.

SIGNAL NAMES ON THE SCHEMATICS HAVE AN L OR H SUFFIX TO INDICATE A LOW OR HIGH RESPECTIVE "TRUE" LEVEL.

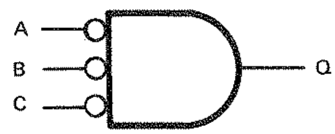


DENOTES INVERTER



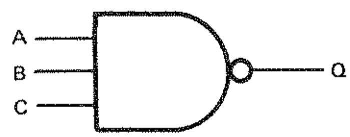
DENOTES "AND" GATE

A	B	C	Q
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	1



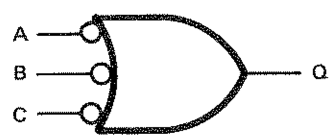
DENOTES "AND" GATE WITH INVERTED INPUTS

A	B	C	Q
0	0	0	1
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	0



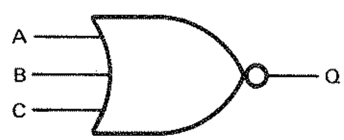
DENOTES "NAND" GATE: "AND" WITH INVERTED OUTPUT.

A	B	C	Q
0	0	0	1
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	0



DENOTES "OR" GATE WITH INVERTED INPUTS.

A	B	C	Q
0	0	0	1
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	0



DENOTES "NOR" GATE: "OR" WITH INVERTED OUTPUT.

A	B	C	Q
0	0	0	1
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	0

SERVICE GROUP A

Service Group A contains theory and service information for the basic 3495A Scanner.

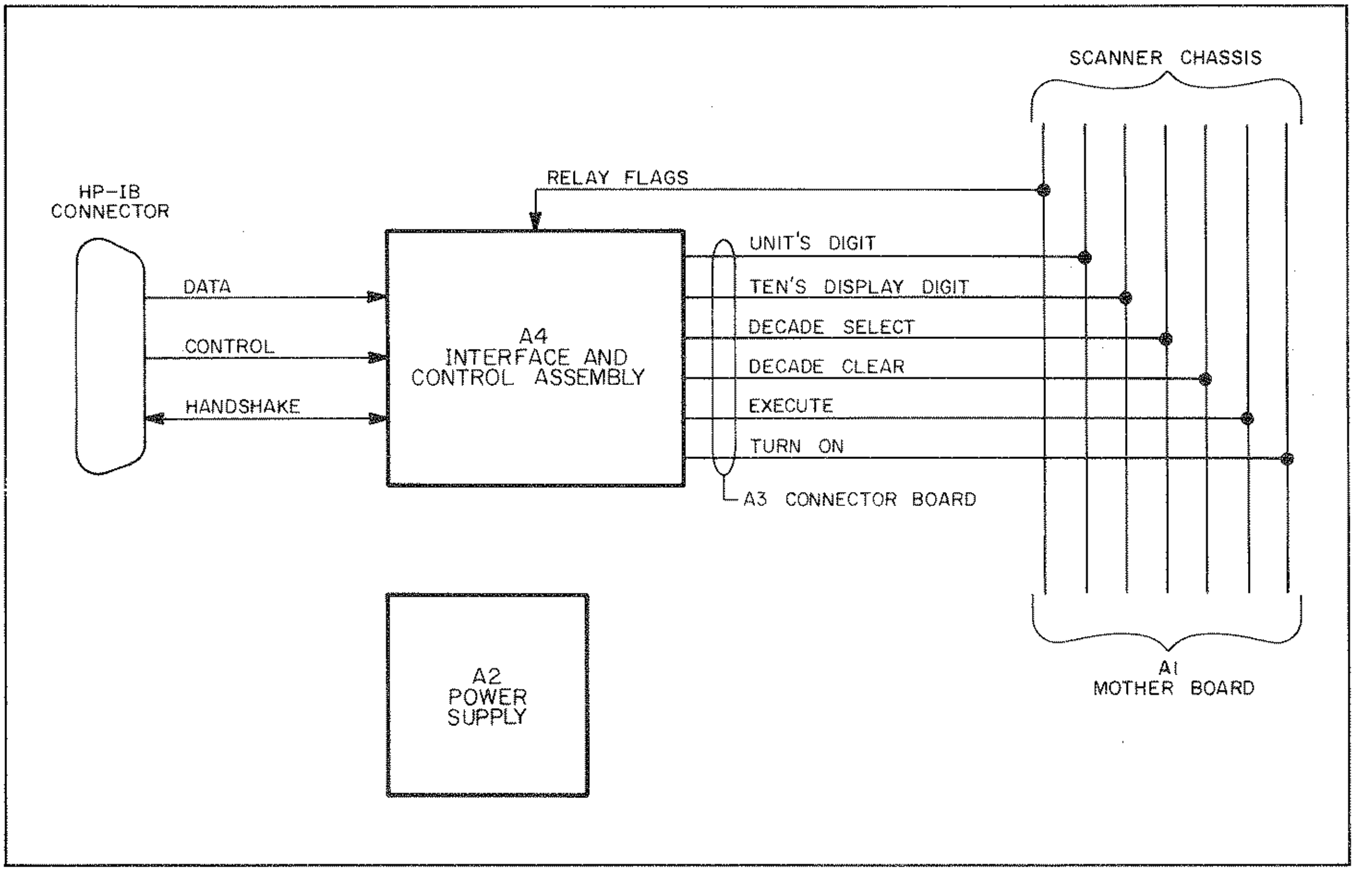


Figure 7-A-1. Service Group A.

Service information on the following assemblies is in this service group:

Scanner Chassis
A2 Power Supply Assembly
A4 Interface and Control Assembly

with references made to the A2 mother board and the A3 connector assembly.

SERVICE GROUP A
BASIC SCANNER

7-A-1. The basic scanner does not consist of any channels. It does consist of the standard chassis, the A1 Mother Board, the A2 Power Supply, the A3 Control Connector Assembly, and the A4 Interface and Control Assembly.

7-A-2. The A4 Interface and Control Assembly interprets commands and instructions from the HP–IB and executes them on appropriate channels.

7-A-3. Information in this service group is presented as follows:

a. Power Supply Checks
b. A2 Service Material
c. A4 Theory of Operation
d. A4 Service Material

7-A-4. SERVICE.

7-A-5. The chassis rarely develops troubles under normal operating conditions. The rear door should be kept on, in good shape, and closed to avoid excessive air flow through the scanner, which may degrade performance. All moving parts should be periodically checked.

7-A-6. The A1 mother board and A3 connector are connector assemblies and require no periodic or special service.

7-A-7. POWER SUPPLY CHECKS.

7-A-8. Check the + 12 volt power supply with a voltmeter across the + 12 and GND Pins on the A2 assembly. A reading of + 12 volts ± 5% should be obtained. This supply is used by the A10 High/Low relay control circuit, A40 relay drive circuit, and the A13, A22 and A25 relay assemblies. Filtering is provided by C2, regulation through the combined action of U2 and CR5. Q2 is the current pass transistor and R8 provides current sensing for U2. The full load output current for this supply is approximately 1.38 amperes at 25°C.

7-A-9. Check the + 5 volt power supply with a voltmeter across the + 5 and GND pins of the A2 assembly. This supply should read + 5 volts ± 3% if the adjustment in Section V was done properly. The + 5 volt supply is used by the A4, A5, A10, and A40 assemblies. Filtering is provided by C1 and C3, regulation through the combined action of U1 and CR1. Q1 is the current pass transistor and R9 in parallel with R10 provides current sensing for Q2. The full load output current is about 4.9 amperes at 25°C.

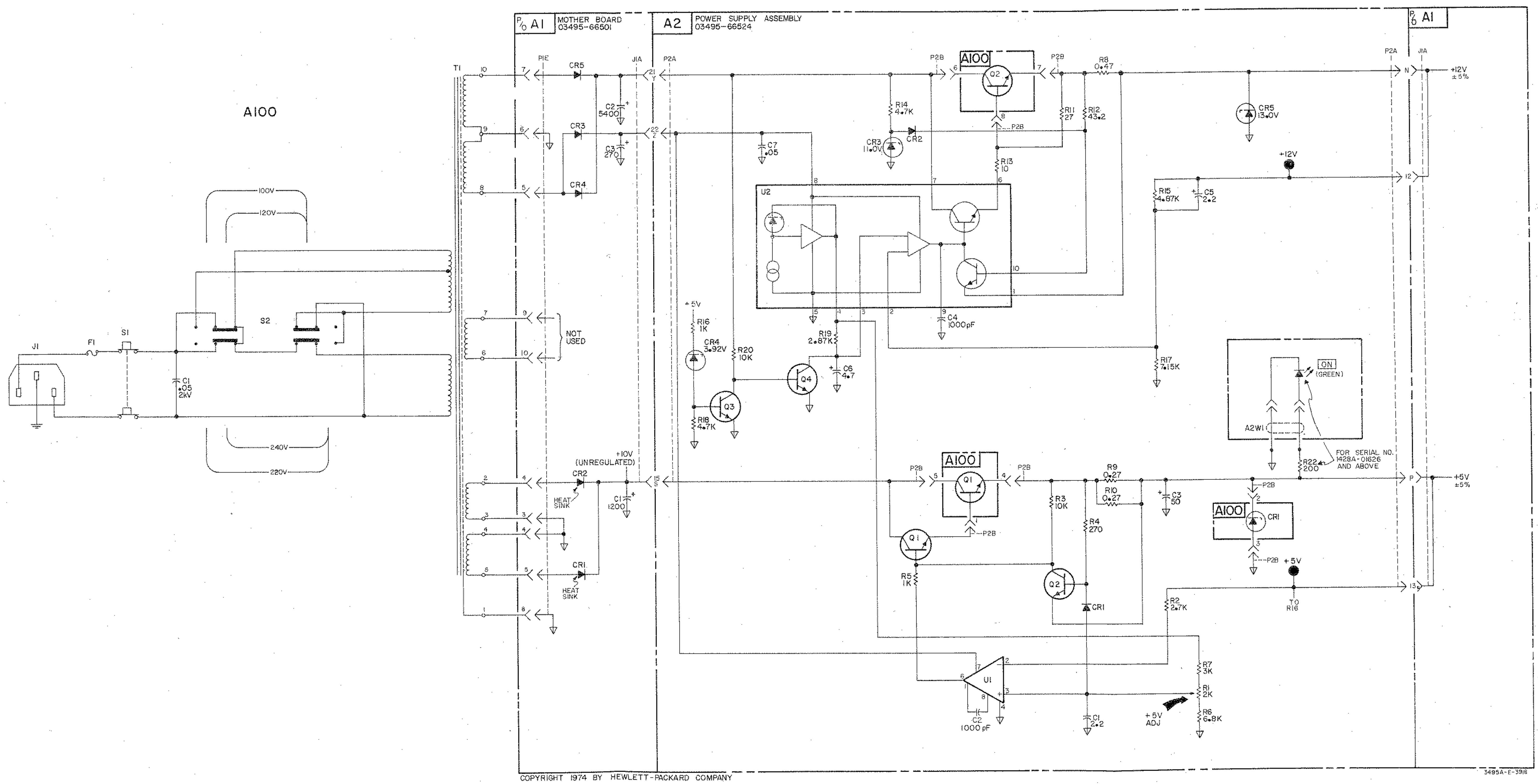
7-A-10. An unregulated + 10 volt supply is provided at the positive terminal of C1 on the A1 mother board assembly. This supply is used by the A5 and A6 display assemblies and is a source for the A2 +5 volt regulated supply. Check this supply voltage for approximately + 10 volts with the 3495A cleared (all channels open).

Table 7-A-1. Replaceable Parts: Power Supply A1, A2, A3 and A100.

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A1	03495-66501	1	MOTHER BOARD ASSY	28480	03495-66501
A1C1	0180-2566	1	CAPACITOR-FXD; .012F +100 -10% 16VDC AL	90201	20-36237
A1C2	0180-0408		CAPACITOR-FXD; 5400UF +75 -10% 25VDC AL	28480	0180-0408
A1C3	0180-0582	1	CAPACITOR-FXD; 270UF +100 -10% 40VDC AL	04200	6720277H040DT2C
A1CR1	1901-0200	4	DIODE-PWR RECT 100V 1.5A	04713	SR1846-9
	1400-0507	4	CLAMP; CABLE TIE; 2 DIA .095 W 8 L NYL	59730	TY-232M
A1CR2	1901-0200		DIODE-PWR RECT 100V 1.5A	04713	SR1846-9
	1400-0507		CLAMP; CABLE TIE; 2 DIA .095 W 8 L NYL	59730	TY-232M
A1CR3	1901-0028	1	DIODE-PWR RECT 400V 750MA	04713	SR1358-9
A1CR4	1901-0200		DIODE-PWR RECT 100V 1.5A	04713	SR1846-9
	1400-0507		CLAMP; CABLE TIE; 2 DIA .095 W 8 L NYL	59730	TY-232M
A1CR5	1901-0200		DIODE-PWR RECT 100V 1.5A	04713	SR1846-9
	1400-0507		CLAMP; CABLE TIE; 2 DIA .095 W 8 L NYL	59730	TY-232M
		1	A1 MISCELLANEOUS		
	03495-26501	1	BOARD, BLANK PC	28480	03495-26501
	1205-0033	2	HEAT-DISSIPATOR; SGL; TO-5 PKG	28480	1205-0033
	1251-3750	1	CONNECTOR, POST TYPE	28480	1251-3750
	1251-1887	6	CONNECTOR; PC EDGE; 22-CONT; DIP SOLDER	71785	252-22-30-340
A2	03495-66524	1	POWER SUPPLY ASSY	28480	03495-66524
A2C1	0180-0197	3	CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A2C2	0150-0050	2	CAPACITOR-FXD 1000PF +80-20% 1000WVDC	28480	0150-0050
A2C3	0180-0339	1	CAPACITOR-FXD; 50UF+75-10% 16VDC AL	56289	30D506G016CB2
A2C4	0150-0050		CAPACITOR-FXD 1000PF +80-20% 1000WVDC	28480	0150-0050
A2C5	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A2C6	0180-0309	2	CAPACITOR-FXD; 4.7UF+-20% 10VDC TA	56289	150D475X0010A2
A2C7	0150-0096	1	CAPACITOR-FXD .05UF +80-20% 100WVDC CER	28480	0150-0096
A2CR1	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A2CR2	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A2CR3	1902-3171	1	DIODE-ZNR 11V 5% DO-7 PD=.4W TC=+.062%	04713	SZ 10939-194
A2CR4	1902-3062	1	DIODE-ZNR 3.92V 5% DO-7 PD=.4W TC=	04713	SZ 10939-65
A2CR5	1902-0629	1	DIODE-ZNR 13V 5% PD=5W	28480	1902-0629
A2Q1	1854-0039	1	TRANSISTOR NPN 2N3053 SI PD=1W	04713	2N3053
A2Q2	1854-0071	4	TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A2Q3	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A2Q4	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A2R1	2100-3273	1	RESISTOR-VAR TRMR 2KOHM 10% C SIDE ADJ	32997	3389H
A2R2	0683-2725	1	RESISTOR 2.7K 5% .25W CC TUBULAR	01121	CB2725
A2R3	0684-1031	3	RESISTOR 10K 10% .25W CC TUBULAR	01121	CB1031
A2R4	0683-2715	1	RESISTOR 270 OHM 5% .25W CC TUBULAR	01121	CB2715
A2R5	0684-1021	2	RESISTOR 1K 10% .25W CC TUBULAR	01121	CB1021
A2R6	0683-6825	1	RESISTOR 6.8K 5% .25W CC TUBULAR	01121	CB6825
A2R7	0683-3025	1	RESISTOR 3K 5% .25W CC TUBULAR	01121	CB3025
A2R8	0811-1662	1	RESISTOR .47 OHM 5% 2W PW TUBULAR	75042	BWH2-47/100-J
A2R9	0811-1659	2	RESISTOR .27 OHM 5% 2W PW TUBULAR	75042	BWH2-27/100-J
A2R10	0811-1659		RESISTOR .27 OHM 5% 2W PW TUBULAR	75042	BWH2-27/100-J
A2R11	0683-2705	1	RESISTOR 27 OHM 5% .25W F TUBULAR	01121	CB2705
A2R12	0757-0392	1	RESISTOR 43.2 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-43R2-F
A2R13	0684-1001	1	RESISTOR 10 OHM 10% .25W CC TUBULAR	01121	CB1001
A2R14	0683-4725	14	RESISTOR 4.7K 5% .25W CC TUBULAR	01121	CB4725
A2R15	0698-4444	1	RESISTOR 4.87K 1% .125W F TUBULAR	16299	C4-1/8-T0-4871-F
A2R16	0684-1021		RESISTOR 1K 10% .25W CC TUBULAR	01121	CB1021
A2R17	0698-4471	1	RESISTOR 7.15K 1% .125W F TUBULAR	24546	C4-1/8-T0-7151-F
A2R18	0684-4721	1	RESISTOR 4.7K 10% .25W CC TUBULAR	01121	CB4721
A2R19	0698-3151	1	RESISTOR 2.87K 1% .125W F TUBULAR	16299	C4-1/8-T0-2871-F
A2R20	0684-1031		RESISTOR 10K 10% .25W CC TUBULAR	01121	CB1031
A2R22	0757-0407	1	RESISTOR 200 1% .125W	03292	C4-1/8-T0-201-F
A2U1	1820-0223	1	IC LIN LM301AH AMPLIFIER	27014	LM301AH
A2U2	1820-0196	1	IC LIN REGULATOR	07263	723HC
A2W1	03495-61606	1	CABLE ASSY	28480	03495-61606
			A2 MISCELLANEOUS		
	1251-3751	1	CONNECTOR, POST TYPE	28480	1251-3751
	5000-9043	4	PIN, EXTRACTOR	28480	5000-9043
	5040-6843	3	EXTRACTOR, PC BOARD	28480	5040-6843
A3	03495-66503	1	CONNECTOR ASSY	28480	03495-66503
			A3 MISCELLANEOUS		
	03495-26503	1	BOARD, BLANK PC	28480	03495-26503
	1251-2875	2	CONNECTOR; PC EDGE; 22-CONT; EXTENDER	71785	251-22-30-380
	5000-9043		PIN:P.C. BOARD EXTRACTOR	28480	5000-9043
	5040-6843		EXTRACTOR, P.C. BOARD	28480	5040-6843

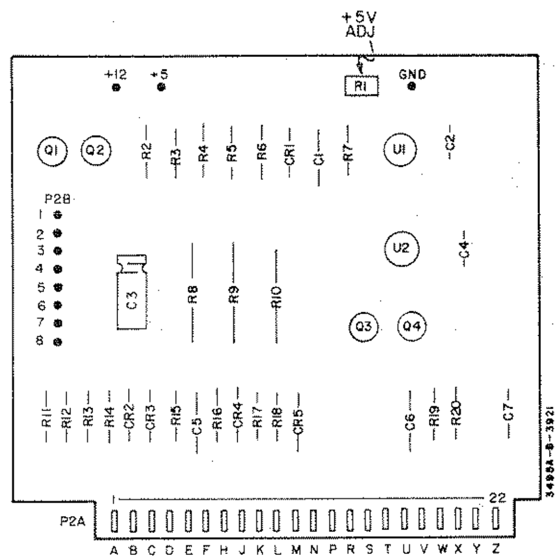
Table 7-A-1. Replaceable Parts: Power Supply A1, A2, A3 and A100 (Cont'd).

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A100	NONE	1	CHASSIS		
A100C1	0160-0904		C: FXD CER 0.05UF 20% 1000VDCW	56289	41C 169A4-CDH
A100CR1	1902-1232		DIODE: ZNR 1N3997R 5.6V 10%	04713	1N3997R
A100F1	2110-0312		FUSE: CARTRIDGE 1AMP 250V SLOW-BLOW	71400	MDL-1
A100Q1, Q2	1854-0063		TSTR: SI NPN	80131	SN3055
A100S1	3101-1720		SWITCH: PB 1-STA MODULE DPDT	28480	3101-1720
A100S2	3101-1609		SWITCH: SL 2 DPDT 3A 125VAC	82389	11E-1036
A100T1	9100-3439	1	TRANSFORMER	28480	9100-3439
	03495-00203	1	PANEL, FRONT	28480	03495-00203
	03495-04107	1	DOOR, REAR	28480	03495-04107
	03495-24301	1	LENS, RED	28480	03495-24301
	03495-01228	1	STIFFENER – REAR DOOR	28480	03495-01228
	5060-9835	1	COVER, TOP	28480	5060-9835
	5060-9862	2	COVER, SIDE	28480	5060-9862
	5060-9847	1	COVER, BOTTOM	28480	5060-9847
	5040-7202	1	TRIM, TOP	28480	5040-7202
	5001-0440	2	TRIM, SIDE	28480	5001-0440
	7120-5234	1	LABEL – INFO	28480	7120-5234
	03495-10001		TEST CASSETTE	28480	03495-10001



A

Figure 7-A-3. Power Supply A1, A2, A100.



A2
-hp- Part No. 03495-66524

Figure 7-A-2. A2 Component Locator.

SERVICE GROUP A
A4
THEORY OF OPERATION

7-A-11. GENERAL.

7-A-12. The A4 Interface and Control assembly interprets commands and instructions on the Hewlett-Packard Interface Bus (HP–IB) and controls the channel accordingly. Commands are sent on the HP–IB during the Command mode (ATN line low); channel programming instructions are sent during the Data mode (ATN line high). Six signals pass the commands and instructions to the decade assemblies. Low Thermal Logic decade assemblies (Options 001 and 003) close the three relay contacts of one channel per decade in a break-before-make sequence; Actuator Logic decade assemblies close the two relay contacts of any number of channels per decade simultaneously. Flags are sent to the Interface and Control assembly from the Logic assemblies to hold up the reception of data from the HP–IB while the Logic assemblies are opening or closing relays. A block diagram of the basic 3495A Scanner is shown in Figure 7-A-1. A block diagram of the A4 interface and control assembly is shown in Figure 7-A-4.

7-A-13. Channel Closure.

7-A-14. A channel is closed by the following sequence of operations:

a. The ten's channel digit is stored on A4.

b. The unit's channel digit is stored on A4.

c. Decade Select signal stores the unit's digit and ten's display digit on whichever Logic assembly has a Close address equal to the ten's channel digit stored on A4.

d. "Execute" signal causes the Logic assembly to close the relays of the channel corresponding to the unit's digit stored on the assembly. The unit's digit and ten's display digit stored on the Logic assembly are transferred to the Display assembly.

7-A-15. Channel Clearing.

7-A-16. There are four different ways to open all relays on one or all options:

a. Turn On. At the time of instrument turn-on, all data storage registers are cleared and all relays opened.

b. Decade Clear Address. The Channel Closure sequence opens all relays of a decade if the Logic assembly has a Clear address equal to the ten's channel digit. In Step 3 the Decade Select signal "clears" the unit's and ten's storage registers to an invalid digit code that causes the Execute signal in Step 4 to open all the relays of the decade.

c. "Clear" Instruction or Command. Instruction "C", or SDC or DCL command is received by the A4 assembly and gives a Decades Clear signal which acts as a decade Clear address but instead "clears" all options rather than just the ones having the Clear address.

d. Lone Ten's Channel Digit. A delimiter or an "execute" instruction following a ten's channel digit "clears" the unit's and ten's data registers on A4 and gives the Decade Logic assemblies having a Close or Clear address equal to the ten's channel digit. "Execute" signal then opens all channels of these options.

NOTE

The IFC universal HP–IB command does **not** *open all relays in an option but does clear all accumulated data from the A4 assembly.*

7-A-17. INPUT DATA STORAGE BLOCK.

7-A-18. Seven-bit-parallel ASCII characters being sent on the HP–IB are individually stored in U6 and U12 until they can be digested by the 3495A. This allows faster communication on the HP–IB because the 3495A is configured to allow the low-true Not Data Accepted (NDAC) handshake line to go high (data accepted) immediately after the HP–IB talker drives the Data Valid (DAV) line low (true). A new character may then be put on the HP–IB by a talker and allowed to settle while the 3495A is decoding the previous character and performing accordingly.

7-A-19. Data Store.

7-A-20. The U6 and U12 flip-flops transfer the seven data bits DIO1 through DIO7 to the D1 through D7 lines when Data Store signal goes true.

$$\text{Data Store} = \underbrace{\overset{\text{U8B}}{\overset{\downarrow}{\overline{\text{IFC}}}} \bullet \overset{\text{U8A}}{\overset{\downarrow}{(\text{ATN} + \text{ADR})}}}_{\text{Ready Mode}} \bullet \overset{\text{U4B}}{\overset{\downarrow}{\text{DAVC}}}$$

Data Store occurs at the next Clock pulse after DAV goes true (DAV is clocked to become DAVC) if the HP–IB control signal, Interface Clear, is false ($\overline{\text{IFC}}$) and either the HP–IB is in the Command mode (ATN) or the 3495A is presently addressed to listen (ADR).

7-A-21. Data Clear.

7-A-22. Data Clear signal is developed by the Internal Data-Clear signal in many states of the Control State Machine; it "resets" the Data Storage flip-flops to the ASCII character DEL which is a "no operator" character for the 3495A. The HP–IB control signal IFC also gives Data Clear signal when it unaddresses the 3495A; this is to prevent self-addressing when the last character sent on the HP–IB and stored in U6 and U12 was the 3495A's Listen address.

7-A-23. HANDSHAKE BLOCK.

7-A-24. Each character received by the 3495A during either HP–IB operating mode is done so with a three-line handshake technique in which the 3495A and other HP–IB listeners control the NRFD and NDAC lines, and the HP–IB talker controls the DAV line. The sequence follows:

a. 3495A sets NRFD false and NDAC true, indicating that it is ready for data.

b. HP–IB talker puts an ASCII character on the seven data lines and sets DAV true.

c. 3495A sets NRFD true and NDAC false and stores the data character.

d. HP–IB talker sets DAV false, allowing the 3495A to set NRFD false and NDAC true to indicate readiness for the next data character as in Step 1. The Basic Handshake sequence is illustrated in Figure 3-2 in Section III, General HP–IB Programming.

7-A-25. Not Ready For Data.

7-A-26. The Not Ready For Data handshake signal is defined in Figure 7-A-5.

Section VII SERVICE GROUP A

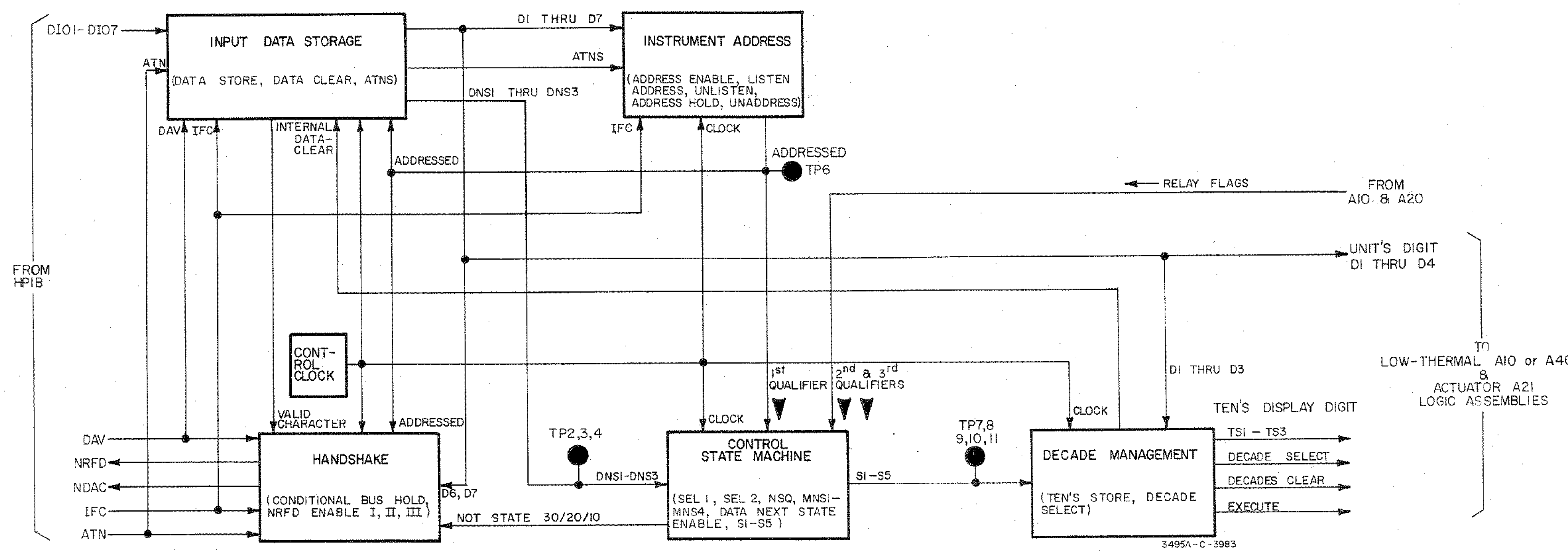


Figure 7-A-4. Interface and Control Block Diagram.

$$\text{NRFD} = \underbrace{\overset{\text{U8B}}{\overline{\text{IFC}}} \bullet \overset{\text{U8A}}{(\text{ATN} + \text{ADR})}}_{\text{Ready Mode}} \overset{\text{U7A}}{\bullet} \Big[\underbrace{\overset{\text{U19A}}{(\text{ATN} \bullet \overline{\text{D6}} \bullet \overline{\text{D7}} \bullet \text{CBH})}}_{\text{NRFD Enable I}} \overset{\text{U13C}}{+} \underbrace{\overset{\text{U13A}}{(\overline{\text{ATN}} \bullet \text{CBH} \bullet \text{ADR})}}_{\text{NRFD Enable II}} \overset{\text{U13C}}{+} \underbrace{\text{DAVC}}_{\text{NRFD Enable III}} \Big]$$

Ready Mode	NRFD Enable I	NRFD Enable II	NRFD Enable III
(The 3495A is ready to receive commands or instructions.)	(A valid non-address command has been received and the 3495A is not ready for a new ASCII character.)	(The 3495A is not ready to receive instructions.)	(Controls NRFD except as overridden by Enable I or Enable II.)

Figure 7-A-5. NRFD Defined.

7-A-27. NRFD goes true to hold up communication on the HP–IB until the 3495A can recognize a character on the HP–IB and perform accordingly; this happens when the 3495A is in the Ready mode and one of the NRFD Enable signals goes true. The 3495A is in the Ready mode if the HP–IB control signal IFC is false ($\overline{\text{IFC}}$) and either the HP–IB is in the Command (ATN) mode or the 3495A is presently addressed to listen (ADR).

7-A-28. NRFD Enable I is true when the HP–IB is in the ATN mode, and a non-address command ($\overline{\text{D6}} \bullet \overline{\text{D7}}$) has just been received, and the Conditional Bus Hold (CBH) signal is true. CBH goes true when Clock (L) goes high at U17 (9) after a valid command (SDC, DCL, GET) is received in state 30, 20 or 10 and drives U4D (10) low; it is then held true outside of state 30, 20 or 10 by ROM U15 at U4D(9). The $\overline{\text{D6}} \bullet \overline{\text{D7}}$ term goes false at the Data Clear signal after state 30, 20 or 10; this overrides CBH and allows commands (including addresses) to be sent on the HP–IB while the state machine is being clocked back to state 30.

7-A-29. NRFD Enable II is true when the HP–IB is in the Data mode ($\overline{\text{ATN}}$), and the 3495A is presently addressed to listen (ADR), and the CBH signal is true. CBH is true when the state-machine is not in state 30, 20 or 10; but it may be overridden by unaddressing the 3495A so that instructions can be sent to other HP–IB listeners while the 3495A is outside of state 30, 20 or 10. (The HP–IB must be put in the Command mode to unaddress the 3495A, and then be put in the Data mode to send messages to other listeners.)

7-A-30. NRFD Enable III is the clocked Data Valid (DAVC) signal from an HP–IB talker. It goes true-and-false to control NRFD except when NRFD must be held true by Enable I or Enable II while the 3495A is getting ready to receive another ASCII character. NRFD Enable III alone controls NRFD when address commands, or instructions to other addressed instruments are being sent on the HP–IB.

7-A-31. Not Data Accepted.

7-A-32. The Not Data Accepted handshake signal is defined as follows:

$$\text{NDAC} = \underbrace{\overset{\text{U8B}}{\overline{\text{IFC}}} \bullet \overset{\text{U8A}}{(\text{ATN} + \text{ADR})}}_{\text{Ready Mode}} \overset{\text{U7B}}{\bullet} \text{DAVC}$$

It is directly controlled by the clocked Data Valid (DAVC) signal from an HP–IB talker. The HP–IB control signal IFC must be false ($\overline{\text{IFC}}$) and either the HP–IB must be in the Command (ATN) mode or the 3495A must be presently addressed to listen (ADR).

Table 7-A-2. Data Next-State Code at A4U14.

SCANNER INPUT CONTROL CHARACTER	ASCII CHARACTER	DATA NEXT-STATE CODE ①			
		DNS3	DNS2	DNS1	OCTAL
HPIB COMMAND MODE					
Selected Device Clear (SDC)	EOT	1	0	1	(5)
Group Execute Trigger (GET)	BS	1	1	0	(6)
Device Clear (DCL)	DC4	1	1	1	(7)
No Operator	All others ②	0	0	0	(0)
HPIB DATA MODE					
Digit	0,1,2,3,4,5,6,7,8,9	0	0	1	(1)
Space	SP	0	1	1	(3)
Clear	C	1	0	1	(5)
Execute	CR, E	1	1	0	(6)
No Operator	NUL, DEL	0	0	0	(0)
Delimiter	All others	1	0	0	(4)

① Determines which state follows state 30, 20 or 10. See Figure 3-6.

② Including all HP-IB address characters.

7-A-33. INSTRUMENT ADDRESS BLOCK.

7-A-34. Comparator U18 and gate U19B monitor the data bits DS1 through DS7 continuously during the HP–IB Command mode (ATNS at U19B) to detect the 3495A's ASCII Listen address character. U19B monitors bits DS6 and DS7 for the code 01 which defines the group of ASCII characters of Table 7-A-2. U18 compares bits DS1 through DS5 with the logical levels of the Listen Address jumpers and gives the Address Enable signal when the two codes become identical; this defines a character within Table 3-1 in Section III, Operating Instructions.

7-A-35. The Listen Address signal gives the Addressed signal when U20B flip-flop is clocked at pin 3. A feedback via gates U3B and U3C holds the flip-flop output at the same level until the Unlisten signal or Unaddress signal occurs. Unlisten signal occurs when the data bits DS1 through DS7 coincide with the ASCII code for "?" and the HP–IB is in the Command mode (ATNS true). Unaddress occurs when the HP–IB IFC line is made low (true) or when the instrument is turned on.

7-A-36. CONTROL STATE MACHINE BLOCK.

7-A-37. The Control State Machine is the heart of the 3495A. It regulates the reception of ASCII characters from the HP–IB and controls the relay decades according to the characters. The Not State 30/20/10 signal controls the NRFD signal in the Handshake circuit; and the state-number bits S1 through S5 control the decade Logic assemblies. Figure 7-A-6 illustrates the control state sequence.

7-A-38. The 5 MHz Control Clock steps the state machine through its 31 states along routes determined by three factors: the next state after 30, 20 or 10 is determined by the ASCII character at the Data Next State ROM U14 (see Table 7-A-2). The next state after 01 and the delay in states 04 and 06 are determined by the Next State Qualifier multiplexer U11; all other states are selected by the Memory Next State ROM U15. The Memory Next State ROM also selects the most significant octal digit of each state number with its output bits MNS4 and MNS5; this is equivalent to selecting a row (30's, 20's, 10's or 0's) in the Control State Diagram, Figure 7-A-6.

7-A-39. The Select multiplexer U10 selects the Data Next State to become the least significant octal digit of the next state number at the next Clock pulse when the present state is 30, 20 or 10. The Memory Next State and Next State Qualifier are selected together to become the least significant octal digit of the next state number at the next Clock pulse when the present state is any other state than 30, 20 or 10. This selection between the two choices for the least significant digit is made by the Data Next State Enable signal from the Memory Next State ROM.

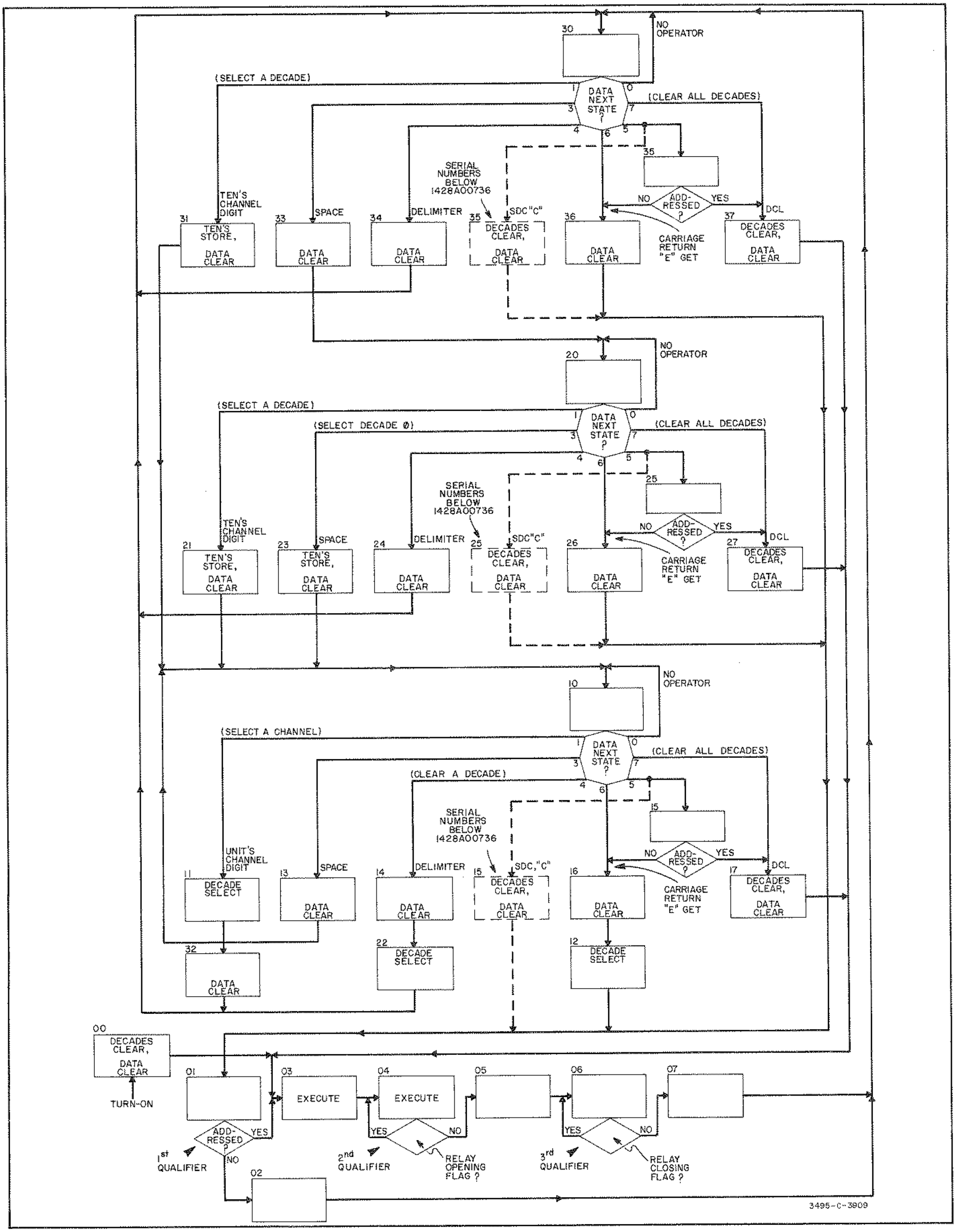


Figure 7-A-6. Control State Diagram.

7-A-40. When the Next State Qualifier and Memory Next State are selected to become the least significant digit of the next state number, the NSO signal from U11 becomes the least significant bit and thus determines whether the state number will be odd or even. NSQ(H) goes high to give an odd state number and route the state machine from state 01 to 03, 04 to 05, or 06 to 07 when the 3495A has been addressed and its relays are not in the process of opening or closing. NSQ(H) is low to allow the 01-to-02 state change when the 3495A is addressed; it also holds the state machine in states 04 and 06 while relays are opening or closing.

7-A-41. When the HP–IB is in the Data mode and the 3495A is addressed, the Not Ready For Data (NRFD) handshake line is held true (low) by Conditional Bus Hold (CBH) signal until the state machine enter state 30, 20 or 10. Then CBH goes false, allowing NRFD to go false so that a new ASCII character may be received. A complete handshake cycle occurs. If the received character gives a "no operator" code at the Data Next State ROM, the state machine remains in state 30, 20 or 10 and another character is received on a handshake cycle. If the character is a valid character, the state machine goes to state X1, X3, X4, X6 or X7 (X = 3, 2 or 1) and CBH goes true again.

7-A-42. See the descriptions of NRFD Enable I and NRFD Enable II for the circumstances when CBH is overridden to allow data characters to be sent on the HP–IB while the 3495A is not in state 30, 20 or 10.

7-A-43. DECADE MANAGEMENT BLOCK.

7-A-44. The Decade Management block contains the five signals shown on the Control State Diagram that control the Logic assemblies and clear the Data Storage flip-flops.

7-A-45. Ten's Store Signal.

7-A-46. Ten's channel digit received during the HP–IB Data mode is stored in the Ten's Storage flip-flops by the Ten's Store signal. This occurs in states 31, 21 and 23 for the following typical instruction sequences:

TYPICAL INSTRUCTION SEQUENCE	TEN'S STORE STATE
Ten's channel digit, unit's channel digit, execute	31
Space, ten's channel digit, unit's channel digit, execute	21
Space, space*, unit's channel digit, execute	23

*Accepted as ten's channel digit zero.

7-A-47. Decade Select Signal.

7-A-48. A unit's channel digit received by the 3495A develops the Decade Select signal in state 11. This selects a decade of channels by decoding the ten's channel digit previously stored in the Ten's Storage flip-flops. The appropriate Decade Select line from U22 causes the logic assembly having the appropriately wired Close address to store the unit's channel digit that is presently stored in the Data Storage flip-flops U6 and U12. The ten's storage data TS1 through TS3 are stored at the same time in the Ten's Display Storage flip-flops on A10 or A20.

7-A-49. Decade Select occurs in states 22 and 12 to clear decades. If a delimiter or an "execute" instruction is received after a ten's channel digit, the Data Clear signal resets the Data Storage flip-flops to Q-low outputs in states 14 and 16. The four data lines D1(L) through D4(L) go low (true), giving an invalid digit code of 15. This causes the logic assemblies having the appropriate Close or Clear address to blank out their displays and open all of their relays at "execute".

7-A-50. Decades Clear Signal.

7-A-51. 3495A's with serial numbers *below* 142800736 will issue a Decades Clear signal in states 35, 25, and 15 when the character "C" is received during the HP–IB Data mode, or when Selected Device Clear (SDC) is received during the Command mode. An invalid digit code of 15 appears at the Unit's Storage Flip-Flops on the logic assemblies. The execute signal in state 03 then opens all relays and blanks all the decade displays if the 3495A is listening.

7-A-52. On 3495A's with serial number of 142800736 or above, the Selected Device Clear (SDC) command or "C" instruction is treated as a Device Clear (DCL) command if the scanner is listening. This results in entering state 37, 27, or 17. A scanner which is not listening will treat the SDC command or "C" instruction as a Carriage Return, "E", or Group Execute Trigger. This results in entering state 36, 26, or 16.

7-A-53. Decades Clear also occurs in states 37, 27 and 17 when the universal Device Clear (DCL) command is received in the HP–IB Command mode. All options are then cleared in state 03.

7-A-54. Execute Signal.

7-A-55. Execute signal redundantly occurs in states 03 and 04 to increase its duration. This is the signal that enables the Relay State Machine on the A10 and A20 Logic assemblies to close and open the channel relays. The number of relays that are closed depends upon the number of passes through Control State 11, the "address" configuration of the options, and the mixture of options.

7-A-56. Data Clear Signal.

7-A-57. Data Clear signal occurs after each data input character, except "no operator", is received on a handshake cycle. By "resetting" the Data Storage flip-flops after each handshake cycle, a "no operator" data code is present the next time the state machine arrives at state 30, 20 or 10. The ASCII character DEL at U6–U12 gives a "no operator" Data Next State code at ROM U14 and holds the state machine in state 30, 20 or 10 until a talker can put a new character on the HP–IB.

7-A-58. SERVICE MATERIAL.

7-A-59. The following pages include service material for the A4 interface and control assembly. Included is a troubleshooting tree, a replaceable parts list, an A4 component locator, an A4 block diagram, and a schematic of the A4 interface and control assembly.

3495A A4 Assembly

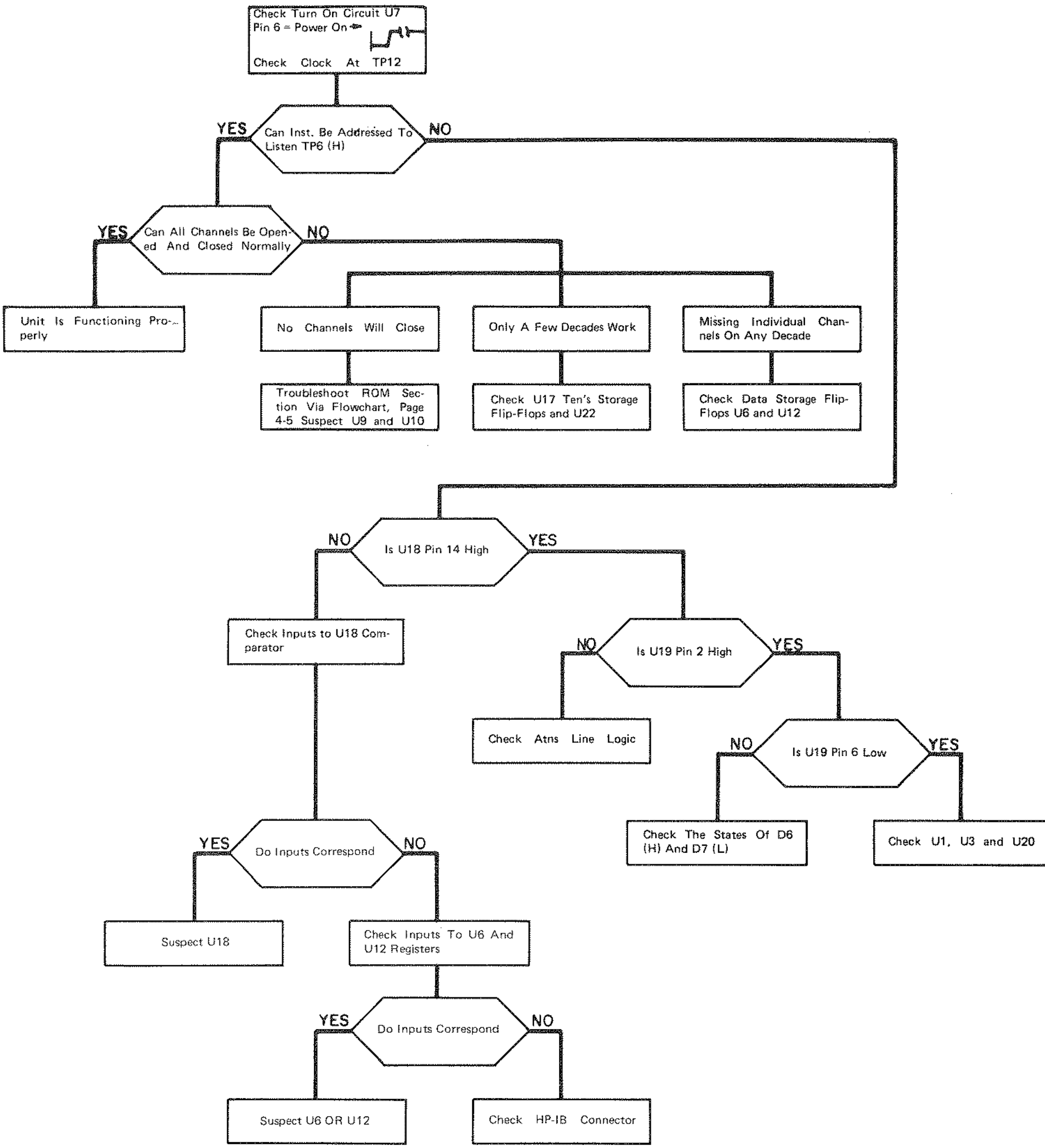


Figure 7-A-7. 3495A A4 Assembly Troubleshooting Tree.

Table 7-A-3. Replaceable Parts Interface and Control A3, A4, A7.

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A4	03495-66504	1	INTERFACE & CONTROL ASSY	28480	03495-66504
	03495-69504		REBUILT EXCHANGE	28480	03495-69504
A4C1	0180-1743	1	CAPACITOR-FXD; .1UF+-10% 35VDC TA-SOLID	56289	150D104X9035A2
A4C2	0150-0093	10	CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A4C3	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A4C4	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A4C5	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A4C6	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A4C7	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A4C8	0180-1701	1	CAPACITOR-FXD; 6.8UF+-20% 6VDC TA-SOLID	56289	150D685X0006A2
A4C9	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A4C10	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A4C11	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A4C12	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
			ADD CAPACITORS C14–C17 FOR S/N 1428A01196 AND ABOVE		
A4C14 thru C17	0160-0134	4	CAPACITOR-FXD 220PF 300 WVDC	28480	0160-0134
A4Q1	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A4R1	1810-0136	2	RESISTIVE NETWORK:	28480	1810-0136
A4R2	1810-0136		RESISTIVE NETWORK:	28480	1810-0136
A4R3	0683-1025	1	RESISTOR 1K 5% .25W CC TUBULAR	01121	CB1025
A4R4	0683-4725		RESISTOR 4.7K 5% .25W CC TUBULAR	01121	CB4725
A4R5	0683-4725		RESISTOR 4.7K 5% .25W CC TUBULAR	01121	CB4725
A4R6	0683-4725		RESISTOR 4.7K 5% .25W CC TUBULAR	01121	CB4725
A4R7	0683-4725		RESISTOR 4.7K 5% .25W CC TUBULAR	01121	CB4725
A4R8	0683-4725		RESISTOR 4.7K 5% .25W CC TUBULAR	01121	CB4725
A4R9	0683-4725		RESISTOR 4.7K 5% .25W CC TUBULAR	01121	CB4725
A4R10	0683-4725		RESISTOR 4.7K 5% .25W CC TUBULAR	01121	CB4725
A4R11	0683-4725		RESISTOR 4.7K 5% .25W CC TUBULAR	01121	CB4725
A4R12	0683-4725		RESISTOR 4.7K 5% .25W CC TUBULAR	01121	CB4725
A4R13	0683-4725		RESISTOR 4.7K 5% .25W CC TUBULAR	01121	CB4725
A4R14	0683-4725		RESISTOR 4.7K 5% .25W CC TUBULAR	01121	CB4725
A4R15	0683-4725		RESISTOR 4.7K 5% .25W CC TUBULAR	01121	CB4725
A4U1	1820-0070	4	IC;DGTL;GATE	01295	SN7430N
A4U2	1820-1056	2	IC DGTL SN74 132 N QUAD SCHMIDT TRIGGER	01295	SN74132N
A4U3	1820-0054	2	IC;DGTL;GATE	01295	SN7400N
A4U4	1820-0054		IC;DGTL;GATE	01295	SN7400N
A4U5	1820-0567	1	IC DGTL MC 4024P MULTIVIBRATOR	04713	MC4024P
A4U6	1820-0839	10	IC DGTL SN74 175 N FLIP-FLOP	01295	SN74175N
A4U7	1820-0621	1	IC DGTL SN74 38 N BUFFER	01295	SN7438N
A4U8	1820-0328	3	IC;DGTL;GATE	01295	SN7402N
A4U9	1820-0788	3	IC DGTL SN74 174 N FLIP-FLOP	01295	SN74174N
A4U10	1820-0616	1	IC;DGTL;MULTIPLEXER	07263	9322DC
A4U11	1820-0620	1	IC DGTL SN74 153 N MULTIPLEXER	01295	SN74153N
A4U12	1820-0839		IC DGTL SN74 175 N FLIP-FLOP	01295	SN74175N
A4U13	1820-0068	1	IC;DGTL;GATE	01295	SN7410N
A4U14	1816-0596	1	IC:IL ROM TTL	28480	1816-0596
A4U15	1816-0588	1	IC:ROM	28480	1816-0588
	1816-0896		FOR S/N 1428A00736 AND ABOVE REPLACES 1816-0588	28480	1816-0588
A4U16	1816-0587		IC: ROM	28480	1816-0587
A4U16	1816-0895		FOR SERIAL NO's. 1428A00736 & ABOVE REPLACES 1816-0895	28480	1816-0895
A4U17	1820-0788		IC DGTL SN74 174 N FLIP-FLOP	01295	SN74174N
A4U18	1820-0706	1	IC;DGTL;COMPARATOR	07263	9324DC
A4U19	1820-0069	1	IC;DGTL;GATE	01295	SN7420N
A4U20	1820-0077	2	IC DGTL SN74 74 N FLIP-FLOP	01295	SN7474N
A4U21	1820-0077		IC DGTL SN74 74 N FLIP-FLOP	01295	SN7474N
A4U22	1820-0214	2	IC DGTL SN74 42 N DECODER	01295	SN7442N
A4Y1	0410-0468	1	CRYSTAL, QUARTZ 5.00 MHZ	28480	0410-0468
			A4 MISCELLANEOUS		
	03495-04103	1	COVER, LOGIC BOARD	28480	03495-04103
	1200-0473	5	SOCKET; ELEC; IC 16-CONT DIP SLDR TERM	28480	1200-0473
	1200-0474	3	SOCKET; ELEC; IC 14-CONT DIP SLDR TERM	28480	1200-0474
	1251-0615	1	CONNECTOR; 14-CONT; MALE; DIP SERIES	28480	1251-0615
	1251-3283	1	CONNECTOR; 24-CONT; FEM; MICRORIBBON	28480	1251-3283
	0360-1647	6	TERMINAL-STUD SGL-PIN	28480	0360-1647
	2190-0034	2	WASHER-LK HLCL NO. 10 .194 IN D .337	28480	2190-0034
	0380-1036	2	STANDOFF-HEX M/FEM .255-LG 6-32-THD	28480	0380-1036
	1251-3691	33	CONNECTOR, SINGLE ROW 36 FXD MALE CONT	22526	65274-1
	1530-1098	3	FASTENER	00000	OBD
	0380-0643	2	APPLIES TO S/N 1428A00506 & GREATER. REPLACES 0380-1036	0046A	OBD #
A7	03495-66507	1	EXTENDER ASSY	28480	03495-66507
	03495-26507	1	BOARD, BLANK PC	28480	03495-26507
	1251-2875		CONNECTOR; PC EDGE; 22-CONT; EXTENDER	71785	251-22-30-380

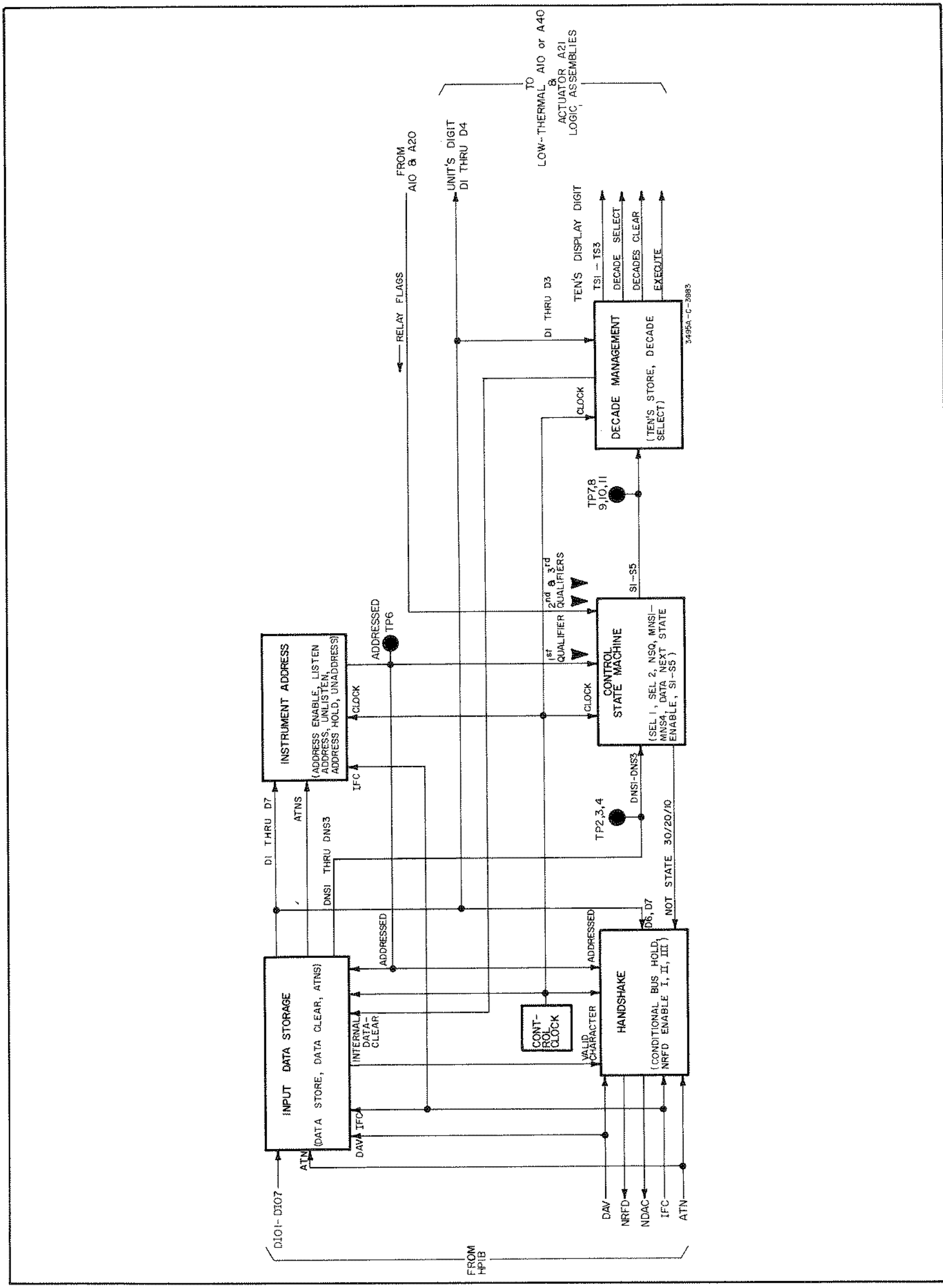
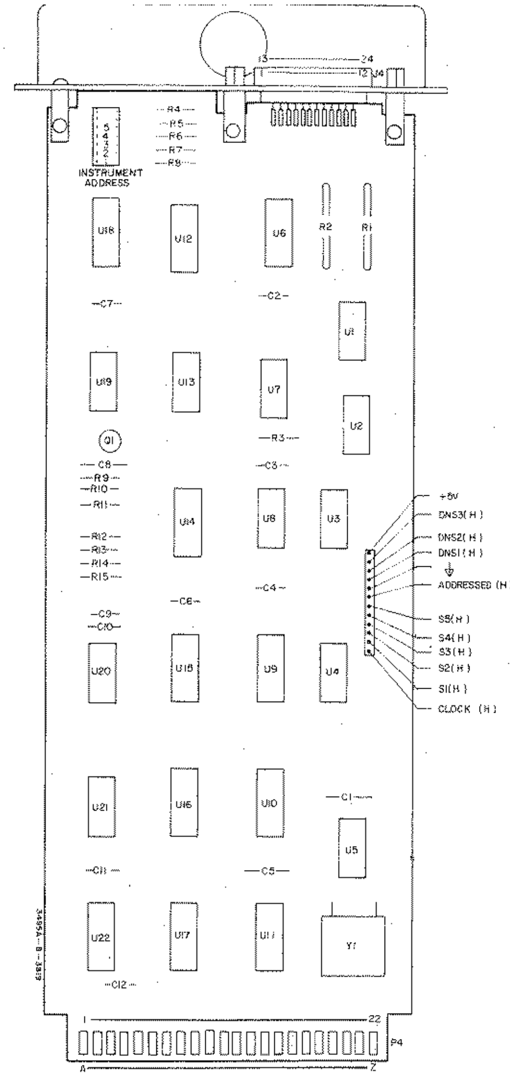
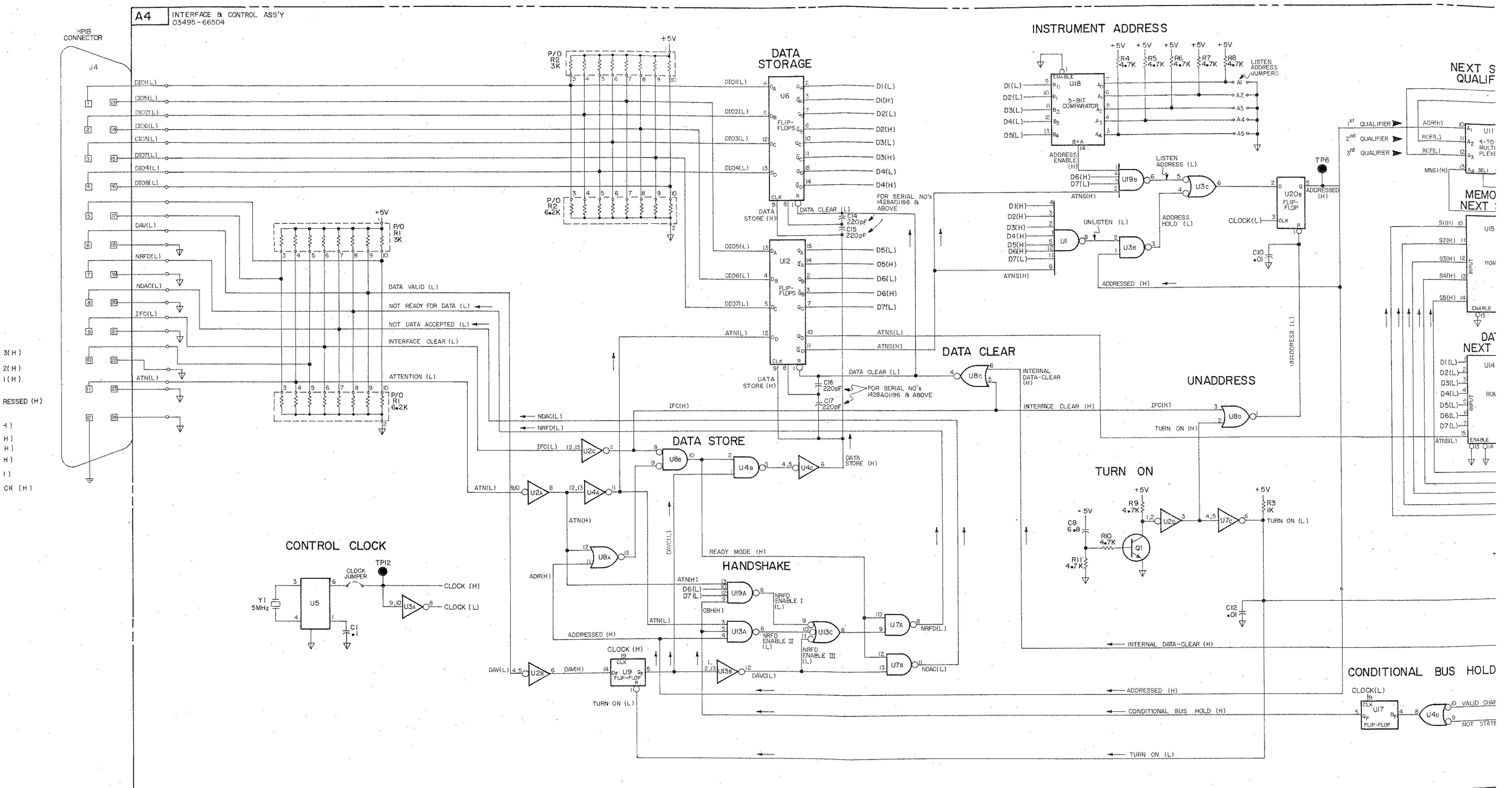


Figure 7-A-8. A4 Block Diagram.



A4
-hp- Part No. 03495-66504
Rev. A

Figure 7-A-9. A4 Component Locator.


A4
INTERFACE & CONTROL ASS'Y
03495-66504
HPIB CONNECTOR
DATA STORAGE
INSTRUMENT ADDRESS
DATA CLEAR
UNADDRESS
DATA STORE
TURN ON
HANDSHAKE
CONTROL CLOCK
CONDITIONAL BUS HOLD

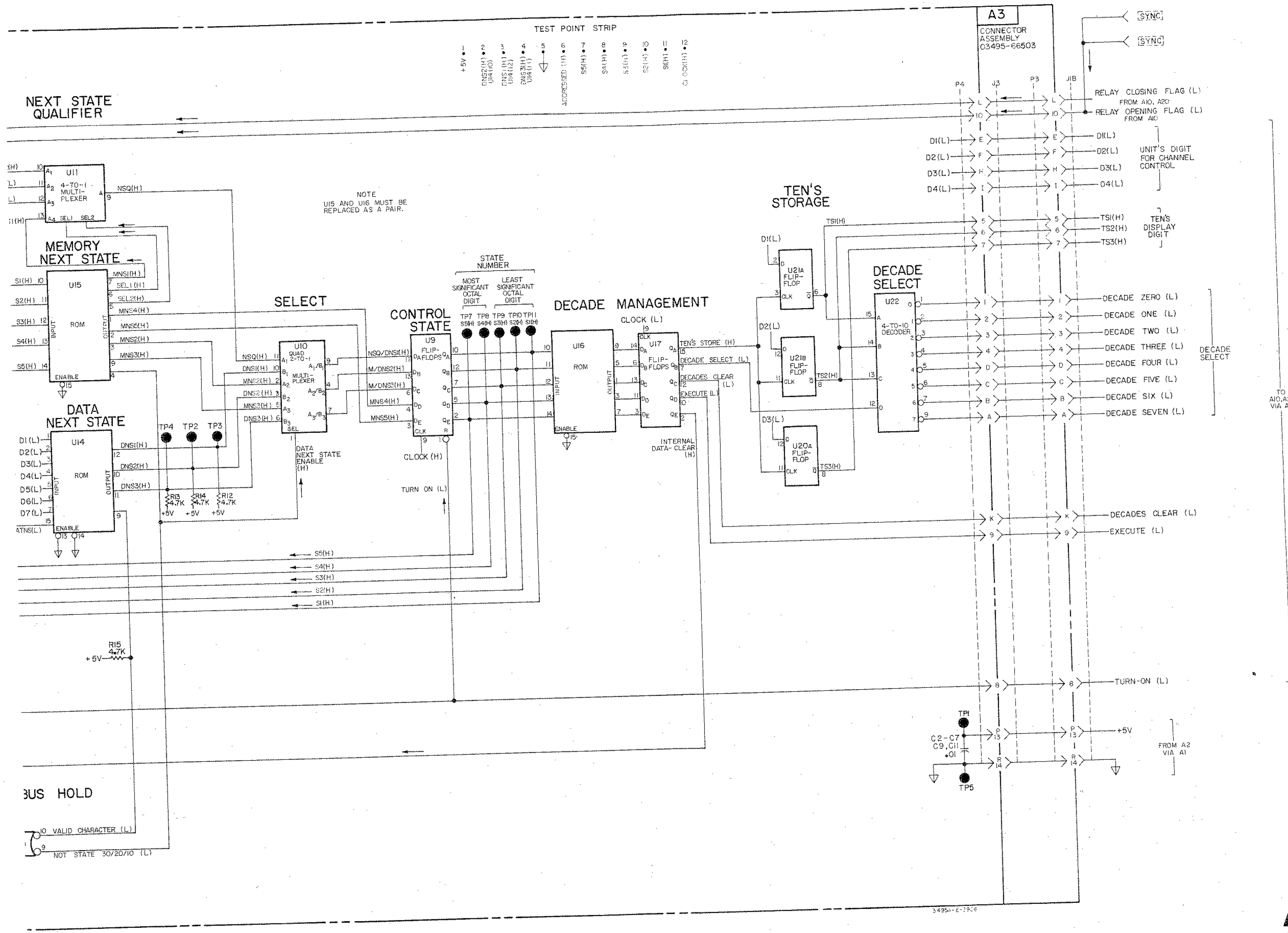


Figure 7-A-10. Interface and Control A4.
7-A-17/7-A-18

SERVICE GROUP B
LOW THERMAL DECADES
Options 001 and 003, Accessories 44401A and 44403A

Service Group B contains theory and service information for low thermal decades on the 3495A Scanner. Options 001 and 003 are included in this service group.

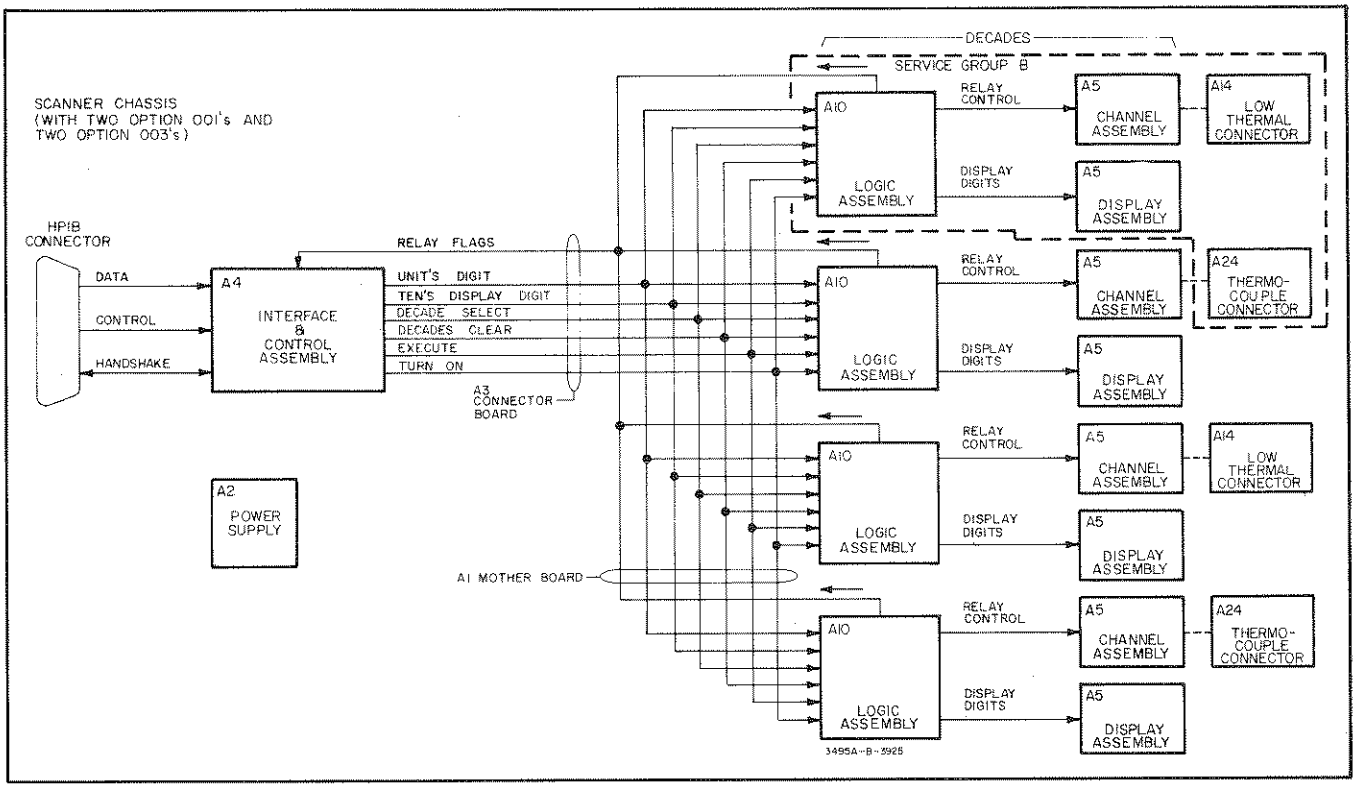


Figure 7-B-1. Service Group B.

Service Information on the following assemblies is in this service group.

A5 Display Assembly
A10 Logic Assembly
A13 Channel Assembly
A14 Low-Thermal Connector
A24 Thermocouple Connector

7-B-1. The low thermal decade options are ten-to-one multiplexers. The scanner assemblies in these options are the A5 Display Assembly, A10 Logic Assembly, A13 Channel Assembly, and A14 or A24 terminal connector. Typical uses of low thermal options include ohms scanning, voltage scanning, and thermocouple temperature measurements.

7-B-2. The A24 reference connector assembly in option 003 replaces the terminal assembly of option 001. The reference connector provides an isothermal environment and a thermistor tied to channel Ø. The thermistor is used to monitor the temperature of the environment. This value is then used to adjust thermocouple voltages to compensate for the connector reference temperature. The adjusted voltages can then be transferred into accurate temperature measurements. The connector and the compensation procedure are discussed in Section III, Applications.

7-B-3. Information in this service group is presented as follows:

a. Low Thermal Decade: Theory of Operation
b. Servicing Aids
c. Servicing Procedures
d. Service Material

A10 THEORY OF OPERATION
(Refer to Figure 7-B-8)

7-B-4. DECADE ADDRESS BLOCK.

7-B-5. Jumper wires placed in the Decade Close Address and Decade Clear Address circuits determine which digits from 0 to 7 accepted by the 3495A as ten's channel digits activate ("address") the given Low Thermal Logic assembly. For a Close address, the Decade Select signal from A4 gives the Ten's Display Store, Unit's Store and Decade Enable signals. Similarly, for a Clear address, the Decade Select signal gives the Unit's Clear and Decade Enable signals. A Clear address overrides a Close address. The Decades Clear signal from A4 functions identically to a Decade Select signal via a Clear address jumper.

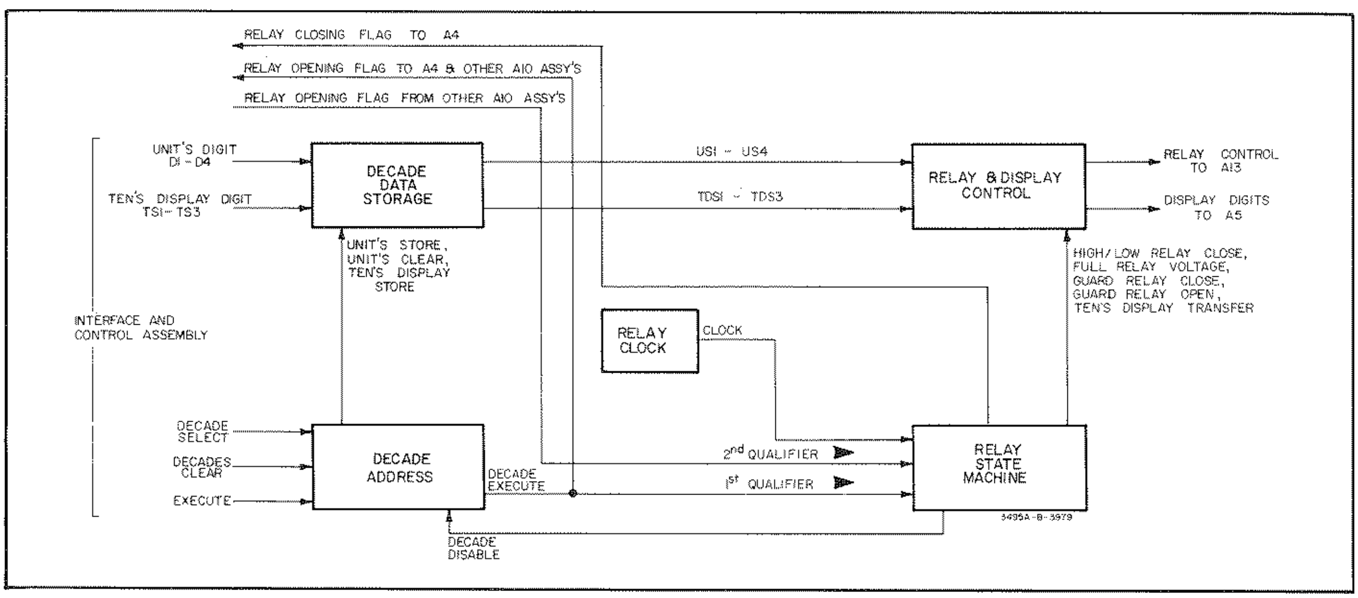


Figure 7-B-2. Low Thermal Block Diagram.

7-B-6. "Execute" signal is received from A4 or A8 after Decade Enable goes true: Decade Execute then allows the Relay State Machine to move out of state 3 and begin the relay sequencing cycle.

7-B-7. Decade Execute is sent back to A4 or A8 as Relay Opening Flag to hold the Control State Machine in state 04 (A4 only) to allow time for relay opening. Decade Execute is made false by Decade Disable in Relay state 4; but this does not necessarily make Relay Opening Flag false, as other A10 assemblies may hold Relay Opening Flag false, as other A10 assemblies may hold Relay Opening Flag low (true) via a wired-OR function. So, Relay Opening Flag goes false only when all A10 assemblies that have been addressed reach state 4.

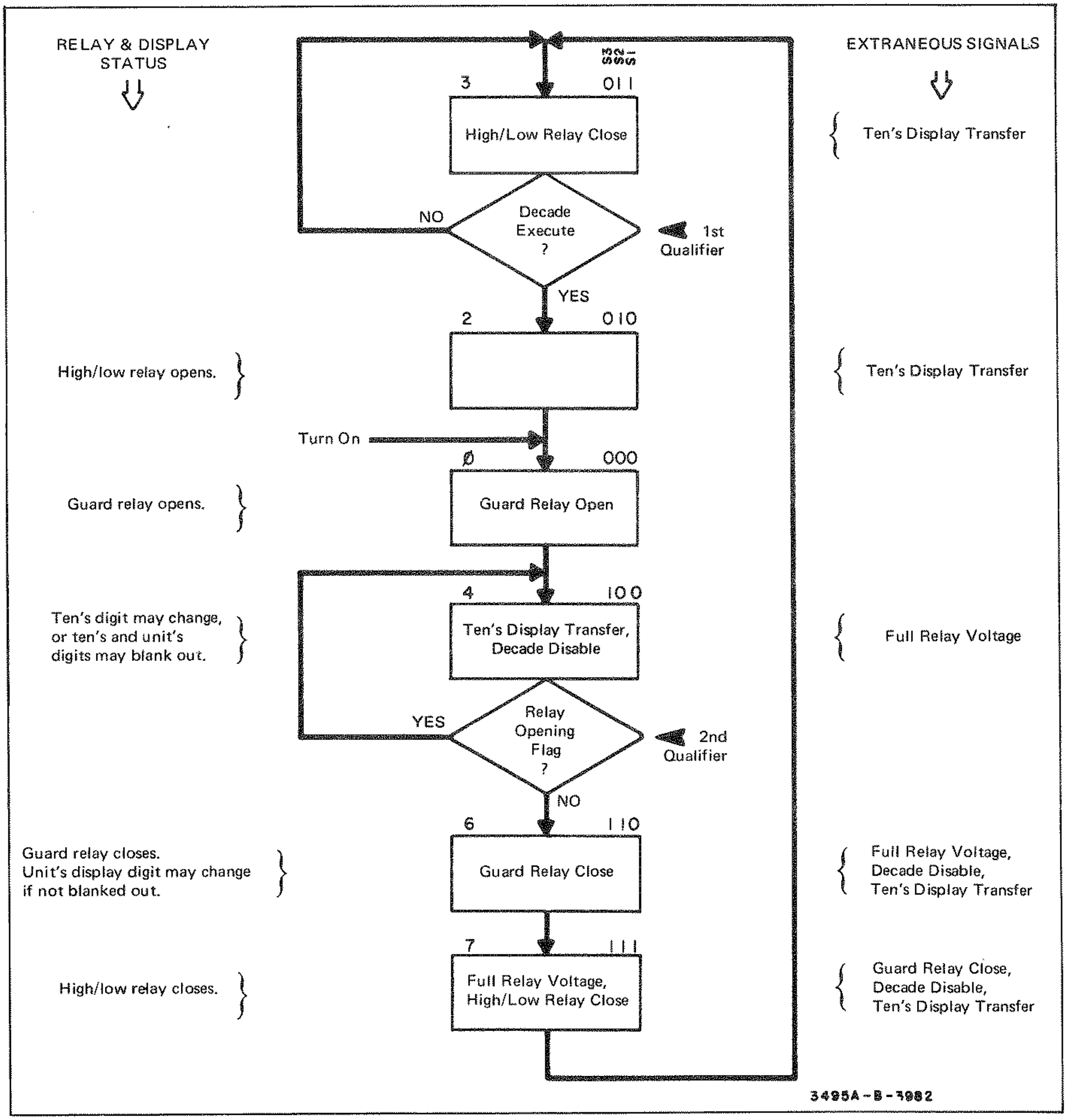


Figure 7-B-3. Low Thermal State Diagram.

7-B-8. DECADE DATA STORAGE BLOCK.

7-B-9. The unit's channel digit stored in the A4 or A8 Data Storage flip-flops is transferred to the Unit's Storage flip-flops when a Decade Select signal from A4 or A8 gives a Unit's Store signal via a decade Close address jumper. The Unit's Storage flip-flops are "cleared" to an invalid digit code of 15 if Decade Select gives the Decade Clear signal via a decade Clear address jumper.

7-B-10. At the same time that the unit's channel digit is being stored on A10, the ten's channel digit (binary code TS1–TS3) is being transferred from A4 or A8 to the Ten's Display Storage flip-flops with the Ten's Display Store signal at U12.

7-B-11. RELAY STATE MACHINE BLOCK.

7-B-12. The Relay Clock advances the state machine through its six states in a timing loop to sequence relay opening and closing. The high/low and guard relays of one channel are held closed or all the relays of the decade are held open in state 3 until Decade Execute, the 1st Qualifier, goes true, at which time the state machine is advanced by the Relay Clock through all of its states and returns to state 3. The previously closed high/low relay opens in state 2, the previously closed guard relay opens in state 0, the new guard relay closes in state 6, and the new high/low relay closes in state 7. The ten's display digit may change in state 4 if the decade is wired for multiple Close addresses; and the unit's display may change in state 6.

7-B-13. The Decade Execute signals of all A10 assemblies are buffered and wired together as an OR function to develop the Relay Opening Flag signal. Relay Opening Flag is the 2nd Qualifier; it may go false and allow the state machine to advance to state 6 only when the Decade Execute signal of each A10 assembly is made false by Decade Disable in state 4. This ensures break-before-make operation. Relay Opening Flag is true during states 2 and 0 on each A10 assembly, but may be true somewhat before or after this interval on a particular assembly since the clocks are not synchronized.

7-B-14. Relay Closing Flag is sent to A4 to hold the Control State Machine in state 06 to allow time for relay closing. It is a wired-OR function derived from the S3 signal of all A10 assemblies and the S2 signal of all A20 assemblies. It therefore occurs in states 4, 6 and 7 on the A10 assemblies and in states 3 and 2 on the A20 assemblies. But it may occur somewhat before or after the required interval on a particular assembly since the Relay Clocks are not synchronized.

7-B-15. Relay Closing Flag goes true in Relay State 4 rather than in state 6, when closure actually begins, to ensure that the much faster operating A4 Control State Machine will not miss this flag. The Control State Machine leaves state 04 when Relay Opening Flag goes false, and quickly advances to state 06 where it stops for the duration of Relay Closing Flag. By having Relay Closing Flag go true before or at the same time that Relay Opening Flag goes false, it is assured that the Control State Machine will not go through state 06 before Relay Closing Flag can go true and stop the Control State Machine in state 06.

7-B-16. RELAY AND DISPLAY CONTROL BLOCK.

7-B-17. The relay and display control circuits operate in strict accordance with the six states of the Relay State Machine as described.

7-B-18. State 3.

7-B-19. All of the channel relays are open or one is closed in state 3. High/Low Relay Close signal is true, enabling Q2 in conjunction with a true Relay Select signal to hold the high/low and guard relays of one channel closed. All Relay Select lines are high (false) if no relays are closed. A1 is cut off, allowing only one-half of the pull-in voltage in state 7 to be applied to the high/low relay coil.

Section VII SERVICE GROUP B

7-B-20. State 2.

7-B-21. High/Low Relay Close signal goes false, cutting off Q2 and opening the high/low relay that was held closed in state 3.

7-B-22. State Ø.

7-B-23. Guard Relay Open signal "clears" the Guard Relay Control U8 flip-flops, presenting an invalid digit code of 15 to the Relay Select decoder U7. All Relay Select lines go high to open the guard relay that was held closed in state 3.

7-B-24. State 4.

7-B-25. The ten's channel digit is transferred from the ten's Display Storage U12 flip-flops to the Ten's Display Control U13 flip-flops by the Ten's Display Transfer signal. Binary coded lines TD1 through TD3 pass the ten's channel digit to the display.

7-B-26. If the Unit's Storage flip-flops have an invalid output digit code of 15 due to having been "cleared" by an invalid digit code from A4 or A8 or the Unit's Clear signal, the binary bits 4 and 8 (US3 and US4) develop the Blank signal at U13 which blanks out the ten's and unit's display digits. Decade Disable signal "clears" the U6 flip-flop, making Decade Enable and Decade Execute (1st Qualifier) signals false. Now, the state machine must stop when it reaches state 3 and wait for Decade Enable to be made true again by another Decade Select and Execute from A4 or A8.

7-B-27. The state machine leaves state 4 when all other A10 assemblies reach state 4 and make Relay Opening Flag false.

7-B-28. State 6.

7-B-29. Guard Relay Close signal transfers the unit's channel digit from U11 to the Guard Relay Control U8 flip-flops. The four-line binary code from U8, GR1 through GR4, is decoded into a single-line signal by Relay Select U7 to close a guard relay. The unit's display digit is driven directly by U8 with the binary coded lines UD1 through UD4.

7-B-30. State 7.

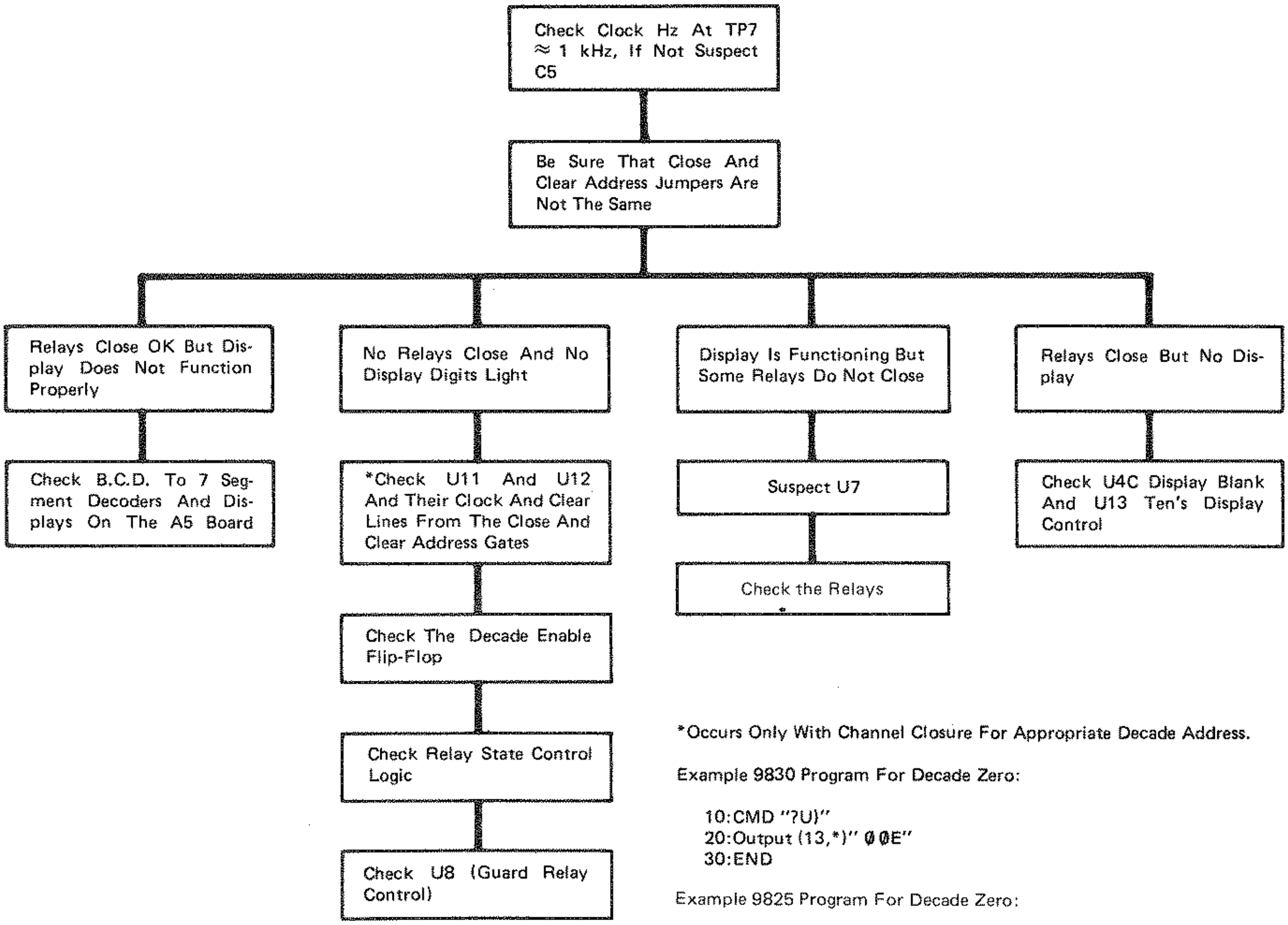
7-B-31. High/Low Relay Close and Full Relay Voltage signals turn on Q2 and Q1 to close the high/low relay on the particular Relay Select line that was driven low in state 6.

7-B-32. When the state machine goes back to state 3, the Full Relay Voltage signal goes false to reduce heat rise in the high/low relay coil but not open the relay. The reduced voltage on the coil also allows faster relay opening on another cycle.

7-B-33. SERVICE MATERIAL.

7-B-34. The following pages include service material for low thermal decade assemblies. Included is a conventional troubleshooting tree (Figure 7-B-4), replaceable parts lists (Table 7-B-1), SA test procedure flowchart (Figure 7-B-5), component locator (Figure 7-B-6), A10 block diagram (Figure 7-B-7), and schematics (Figure 7-B-8).

3495A A10 Assembly



*Occurs Only With Channel Closure For Appropriate Decade Address.

Example 9830 Program For Decade Zero:

```
10:CMD "?U)"
20:Output (13,*)" ØØE"
30:END
```

Example 9825 Program For Decade Zero:

```
10: cmd 7 "?Uj", "OOE"
20: end
```

Figure 7-B-4. Low-Thermal Decades Troubleshooting Tree.

Table 7-B-1. Replaceable Parts: A10 Low Thermal Logic.

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A10	03495-66510	1 thru 4	LOW-THERMAL LOGIC ASSY	28480	03495-66510
A10C1	0160-2964	14	CAPACITOR-FXD .01UF +80-20% 25WVDC CER	28480	0160-2964
A10C2	0160-2964		CAPACITOR-FXD .01UF +80-20% 25WVDC CER	28480	0160-2964
A10C3	0160-2964		CAPACITOR-FXD .01UF +80-20% 25WVDC CER	28480	0160-2964
A10C4	0160-2964		CAPACITOR-FXD .01UF +80-20% 25WVDC CER	28480	0160-2964
A10C5	0180-0197		CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A10C6	0160-2964		CAPACITOR-FXD .01UF +80-20% 25WVDC CER	28480	0160-2964
A10C7	0160-2964		CAPACITOR-FXD .01UF +80-20% 25WVDC CER	28480	0160-2964
A10Q1	1853-0020	2	TRANSISTOR PNP SI CHIP PD=300MW	28480	1853-0020
A10Q2	1853-0020		TRANSISTOR PNP SI CHIP PD=300MW	28480	1853-0020
A10R1	1810-0041	4	CIRCUIT; PSIV; NON-RPRABLE IN	28480	1810-0041
A10R2	1810-0041		CIRCUIT; PSIV; NON-RPRABLE IN	28480	1810-0041
A10R3	0684-3311	11	RESISTOR 330 OHM 10% .25W CC TUBULAR	01121	CB3311
A10R4	0683-1035	6	RESISTOR 10K 5% .25W CC TUBULAR	01121	CB1035
A10R5	0683-1035		RESISTOR 10K 5% .25W CC TUBULAR	01121	CB1035
A10R6	0683-1035		RESISTOR 10K 5% .25W CC TUBULAR	01121	CB1035
A10R7	0683-1035		RESISTOR 10K 5% .25W CC TUBULAR	01121	CB1035
A10R8	0683-1035		RESISTOR 10K 5% .25W CC TUBULAR	01121	CB1035
A10R9	0683-1035		RESISTOR 10K 5% .25W CC TUBULAR	01121	CB1035
A10R10	0683-4725		RESISTOR 4.7K 5% .25W CC TUBULAR	01121	CB4725
A10R11	0698-3122		RESISTOR 412 OHM 1% .125W FOR S/N 1428A00541 AND ABOVE	01992	PHE55-1/8-TO-4120-F
A10S1	1200-0473		SOCKET; ELEC; IC 16-CONT DIP SLDR TERM	28480	1200-0473
A10S2	1200-0473		SOCKET; ELEC; IC 16-CONT DIP SLDR TERM	28480	1200-0473
A10U1	1820-0511	1	IC;DGTL;GATE	01295	SN7408N
A10U2	1820-0070		IC;DGTL;GATE	01295	SN7430N
A10U3	1820-0070		IC;DGTL;GATE	01295	SN7430N
A10U4	1820-0328		IC;DGTL;GATE	01295	SN7402N
A10U5	1820-0281	2	IC DGTL SN74 107 N FLIP-FLOP	01295	SN74107N
A10U6	1820-0281		IC DGTL SN74 107 N FLIP-FLOP	01295	SN74107N
A10U7	1820-0491	1	IC DGTL SN74 145 N DECODER	01295	SN74145N
A10U8	1820-0839		IC DGTL SN74 175 N FLIP-FLOP	01295	SN74175N
A10U9	1820-0577	1	IC DGTL SN74 16 N INVERTER	01295	SN7416N
A10U10	1820-1056		IC DGTL SN74 132 N COUNTER	01295	SN74132N
A10U11	1820-0839		IC DGTL SN74 175 N FLIP-FLOP	01295	SN74175N
A10U12	1820-0839		IC DGTL SN74 175 N FLIP-FLOP	01295	SN74175N
A10U13	1820-0839		IC DGTL SN74 175 N FLIP-FLOP	01295	SN74175N
			A10 MISCELLANEOUS		
	1251-1959	2	CONNECTOR; PC EDGE; 15-CONT; EXTENDER	71785	251-15-30-380
	1251-3535	4	CONNECTOR; 16-CONT; MALE; RECTANGULAR	28480	1251-3535
	5000-9043		PIN:P.C. BOARD EXTRACTOR	28480	5000-9043
	5040-6843		EXTRACTOR, P.C. BOARD	28480	5040-6843

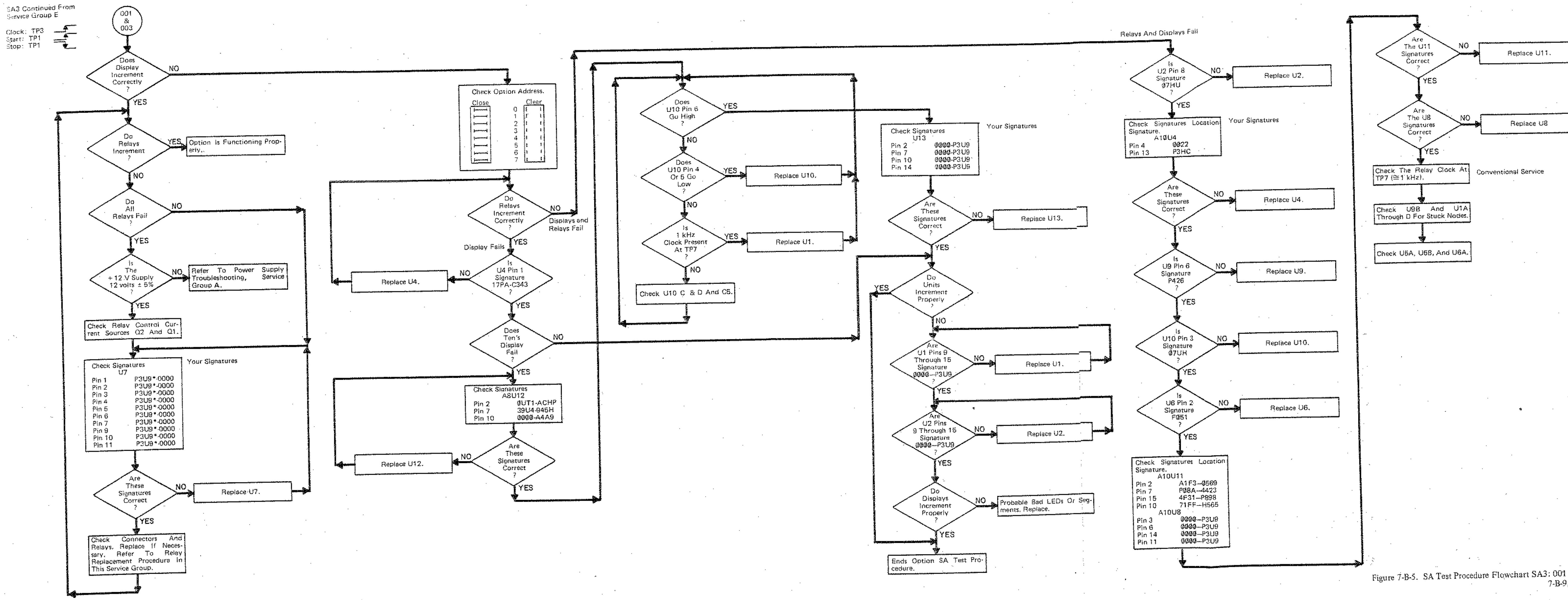


Figure 7-B-5. SA Test Procedure Flowchart SA3: 001 & 003.

SA3: 001 & 003
Instrument Test
A10

U2

Pin	Signature
5	U978
6	FH9U
8	**Ø7HU**
11	P98U
12	HAC7

U4

Pin	Signature
1	**17PA-C343**
2	**4F31-P898**
3	**71FF-H565**
4	**ØØ22**
5	P3HC
6	P3HC
8	**FØ51**
12	ØØ22
13	**P3HC**

U6

Pin	Signature
2	**FØ51**
3	23A8
12	**Ø7UH**

U7

Pin	Signature
1-11	P3U9*-ØØØØ
12-15	ØØØØ-P3U9

U8

Pin	Signature
2	ØØØØ-P3U9
3	ØØØØ-P3U9
4	**A153-Ø569**
5	**PØ8A-4423**
6	ØØØØ-P3U9
7-10	ØØØØ-P3U9
11	ØØØØ-P3U9
12	**71FF-H565**
13	**4F31-P898**
14	ØØØØ-P3U9
15	ØØØØ-P3U9

U9

Pin	Signature
5	**Ø7HU**
6	**P426**

U10

Pin	Signature
1	**P3HC**
2	**P426**
3	**Ø7UH**

U11

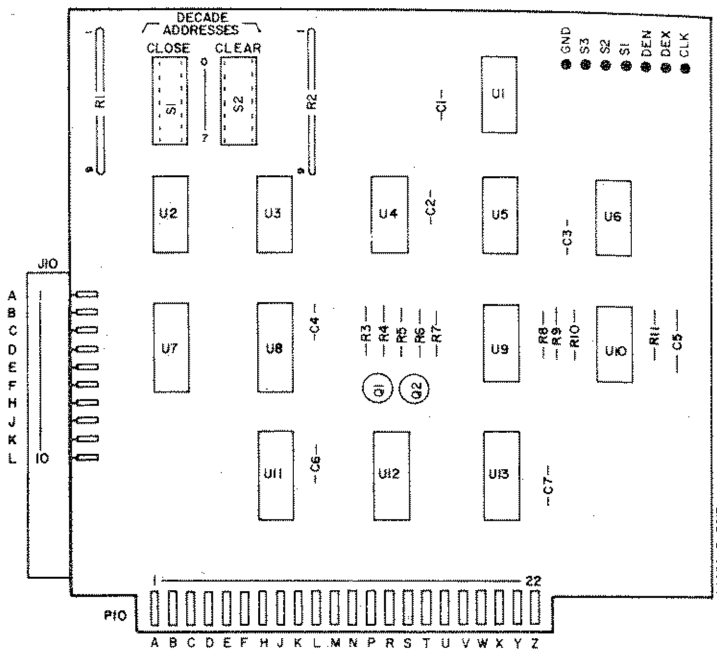
Pin	Signature
1	**P3HC**
2	**A1F3-Ø569**
4	14C3
5	AHC5
6	A7HA-Ø373
7	**PØ8A-4423**
9	**Ø7HU**
10	**71FF-H565**
11	9235-369F
12	2469
13	CP78
14	OC61-AUF8
15	**4F31-P898**

U12

Pin	Signature
2	**ØU77-ACHP**
3	4827-PF8P
4	HFPA
5	Ø158
6	7PA4-HAØH
7	**39U4-9H5H**
9	**Ø7HU**
10	**ØØØØ-A4A9**
11	P3U9-475Ø
12	5296
13	ØØØØ-P3U9

U13

Pin	Signature
2	ØØØØ-P3U9
3	**ØØØØ-P3U9**
4	**ØU77-ACHP**
5	9H5H-39U4
6	**ØØØØ-P3U9**
7	ØØØØ-P3U9
10	ØØØØ-P3U9
12	**ØØØØ-A4A9**
13	**17PA-C343**
14	ØØØØ-P3U9
15	ØØØØ-P3U9



A10
hp Part No.03495-26510

Figure 7-B-6. A10 Component Locator.

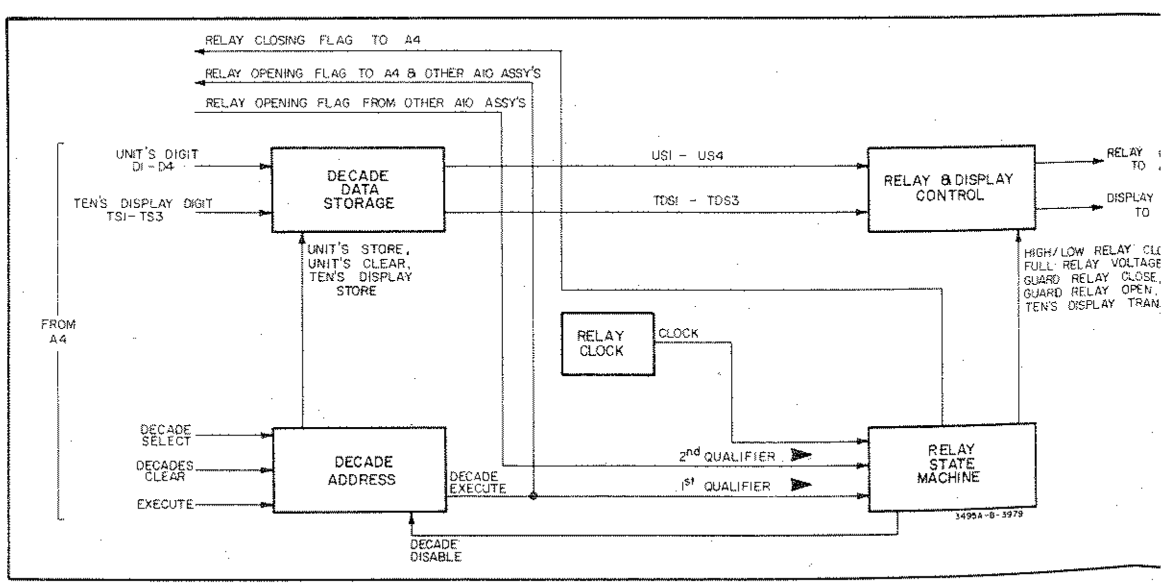
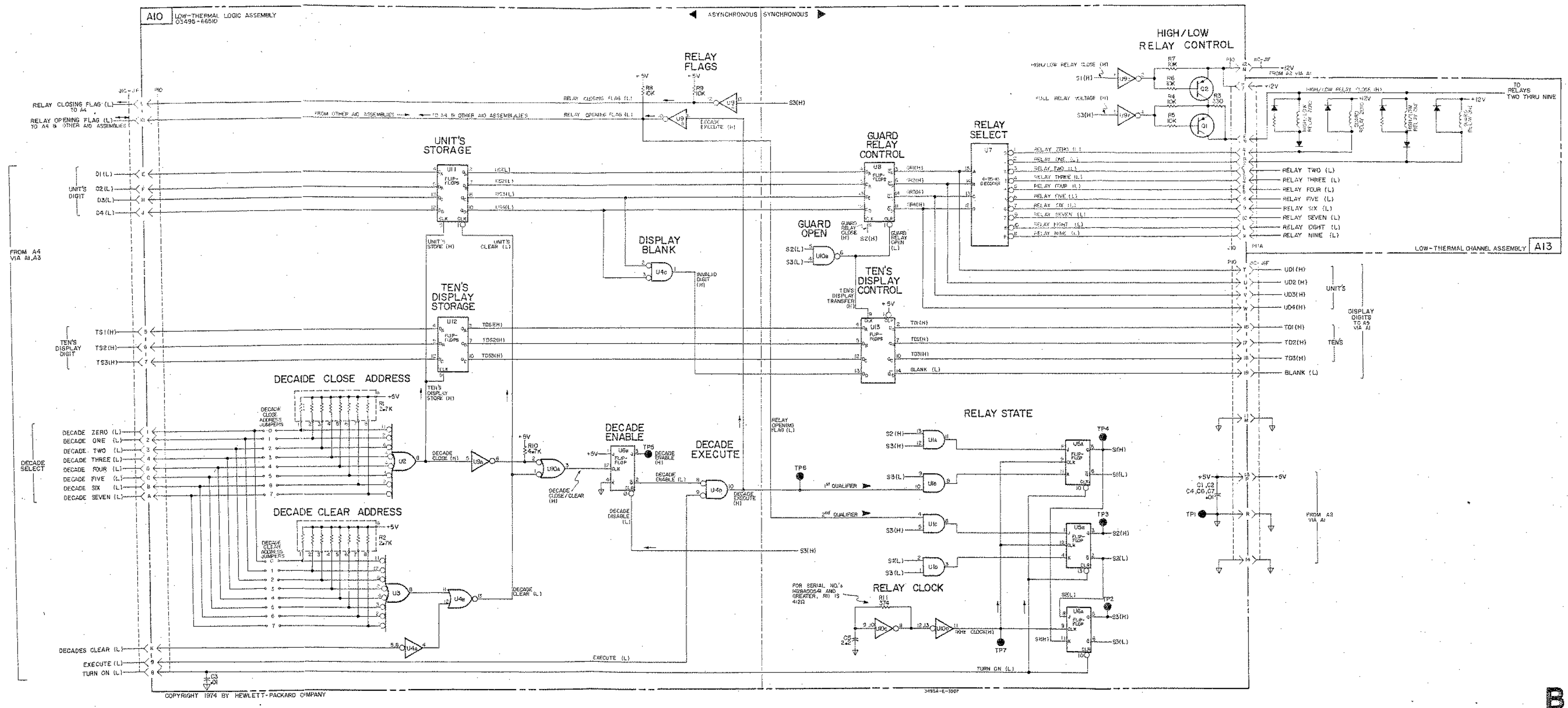


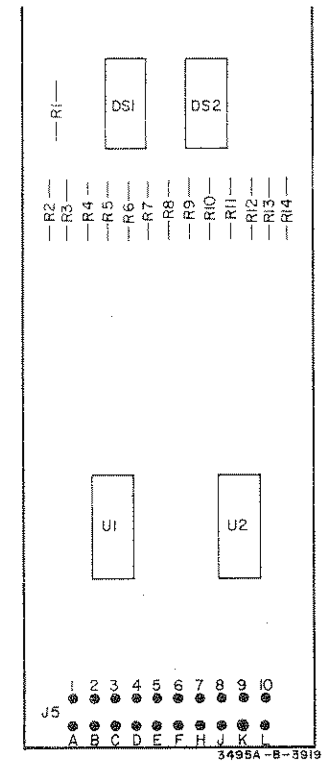
Figure 7-B-7. A10 Block Diagram.



B

Figure 7-B-8. Low Thermal Logic A10.

7-B-11/7-B-12



A5
hp Part No. 03495-66505

Figure 7-B-19. A5 Component Locator.

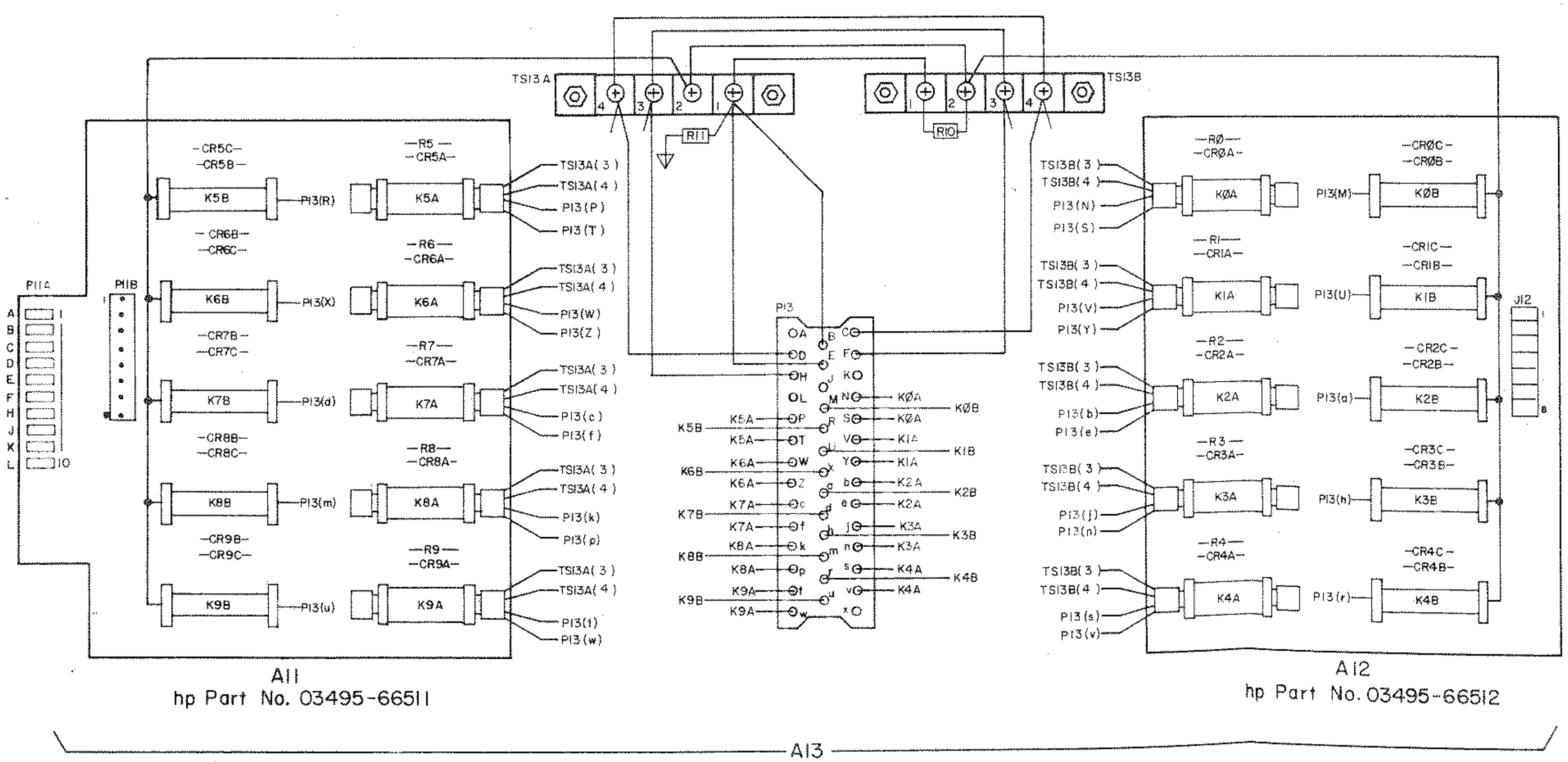
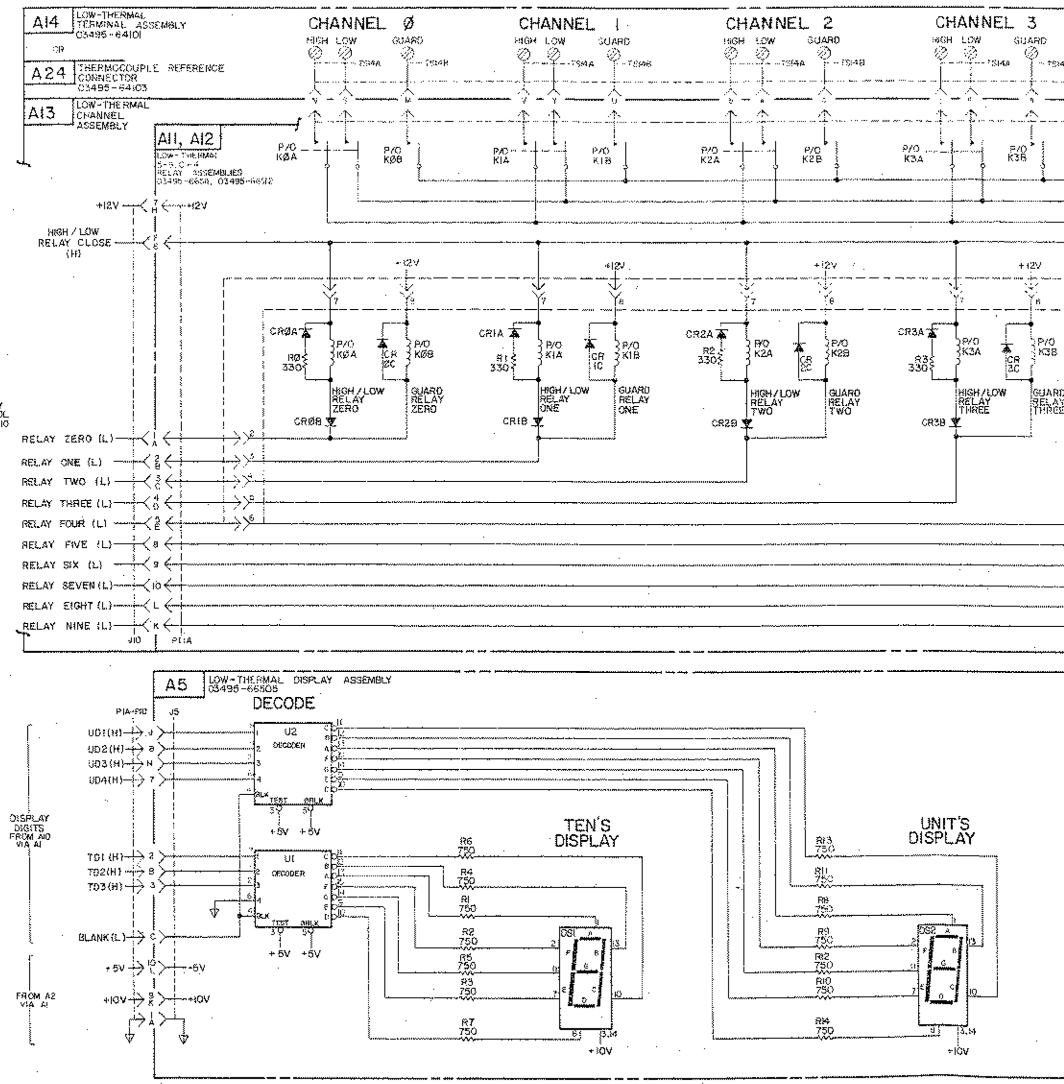
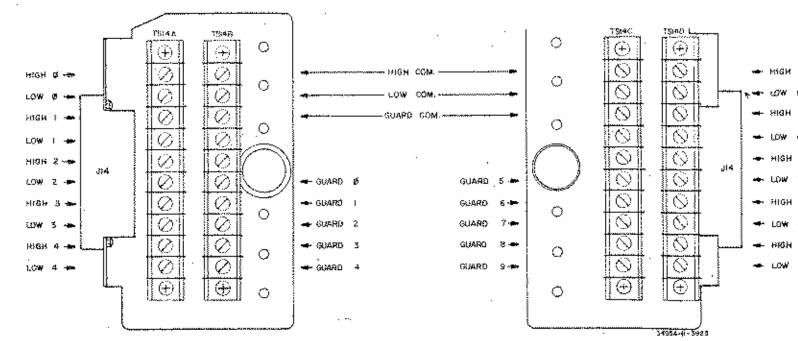
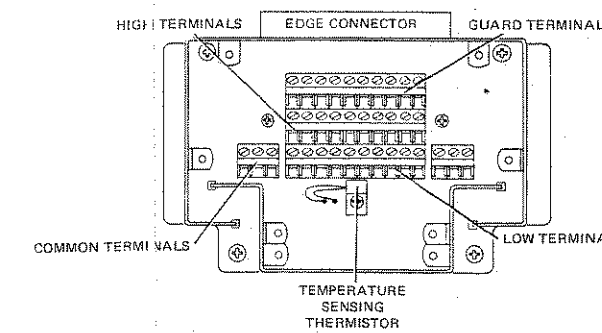


Figure 7-B-20. A13 Component Locator.





A14
-hp- Part No. 03495-64101



A24
-hp- Part No. 03495-64103

B

Figure 7-B-21. Low Thermal Channel/Display A5, A11 through A14, A24.

transferred to the A20 Unit's Storage flip-flops. At the same time the ten's channel digit in the A4 Ten's Storage flip-flops is transferred to the Ten's Display Storage flip-flops. For a decade Clear address jumper, the Unit's Storage flip-flops are "cleared" to an invalid digit code of 15 which opens all of the relays of the decade and blanks the display at "execute" instruction.

7-C-8. RELAY STATE MACHINE BLOCK.

7-C-9. The A20 Relay State Machine is an asynchronous four-state circuit controlled entirely by three qualifier signals: the two external qualifiers – Decade Enable and Decade execute – and the internal qualifier – Flag Time. The four states form a timing loop that allows the relays and front panel display to change status only under certain conditions.

7-C-10. States 0 and 1 demand that the first two qualifiers, Decade Enable and Decade Execute, must go true in this order before any relays may close or open or the display change.

7-C-11. State 3 initiates the Flag Time relay delay interval and satisfies the requirement for a single bit transition between states in an asynchronous state machine. Transfer of data to the relays and display begins at this time. The state exists for only about 30 nanoseconds, just until the third qualifier signal, Flag Time, rises to its "true" level. Ensuring that Flag Time goes true in state 3 allows the inverted Flag Time signal to be used as the fourth qualifier in the next state, 2.

7-C-12. State 2 is the time interval required for relays to close or open; it is set at about 30 ms by the U1 one-shot. Relay Closing Flag is sent to A4 to hold the Control State Machine in state 06 while a change in relay status is taking place. Relay Closing Flag is a wired-OR function, derived from all logic assemblies. The state machine returns to state 0 when Flag Time goes false.

7-C-13. RELAY AND DISPLAY CONTROL BLOCK.

7-C-14. Any number of the ten relays of the decade may be held closed simultaneously by the Relay Control U10 and U6 flip-flops. The combination of relays for closure is transferred from the U11, U17 and U12 flip-flops to U10 and U6 on the positive edge of the Relay Transfer signal in states 3 and 2. The ten's display digit is transferred from U8 to U9 at the same time.

7-C-15. Each time a new unit's channel digit is received by A20 and stored in U15, the Relay Select U16 decoder "set" a new Relays Selected flip-flop. This cumulative process stores all of the numbers of the relays to be closed.

7-C-16. An invalid digit code of 15 from the Unit's Storage flip-flops opens all relays of the decade by "resetting" the Relays Selected flip-flops with binary bits 4 and 8 (US3 and US4). Several 3495A input instruction sequences give the invalid code: A ten's channel digit followed by a delimiter or an "execute" instruction causes A4 to send the invalid digit code to U15 on the D1(L) through D4(L) lines; this is then stored by a Decade Select signal corresponding to a decade Close address. A ten's instruction digit corresponding to a decade Clear address "clears" the U15 flip-flops to the invalid digit code.

7-C-17. Selected Device Clear (SDC) and the "C" instruction develop the decade clear signal if the scanner is presently addressed to listen. A universal device clear (DCL) command develops the decade clear signal even if the scanner is not presently addressed to listen.

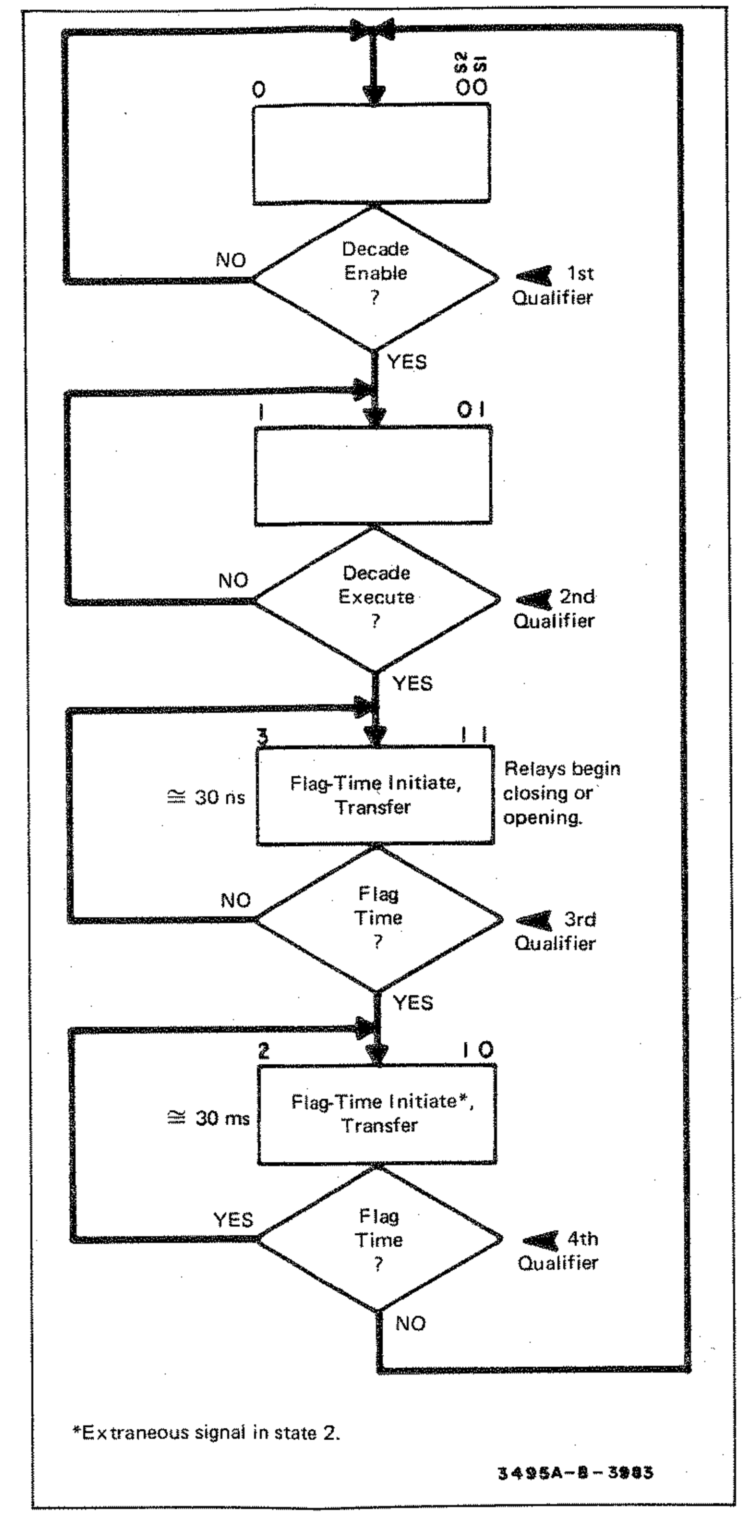


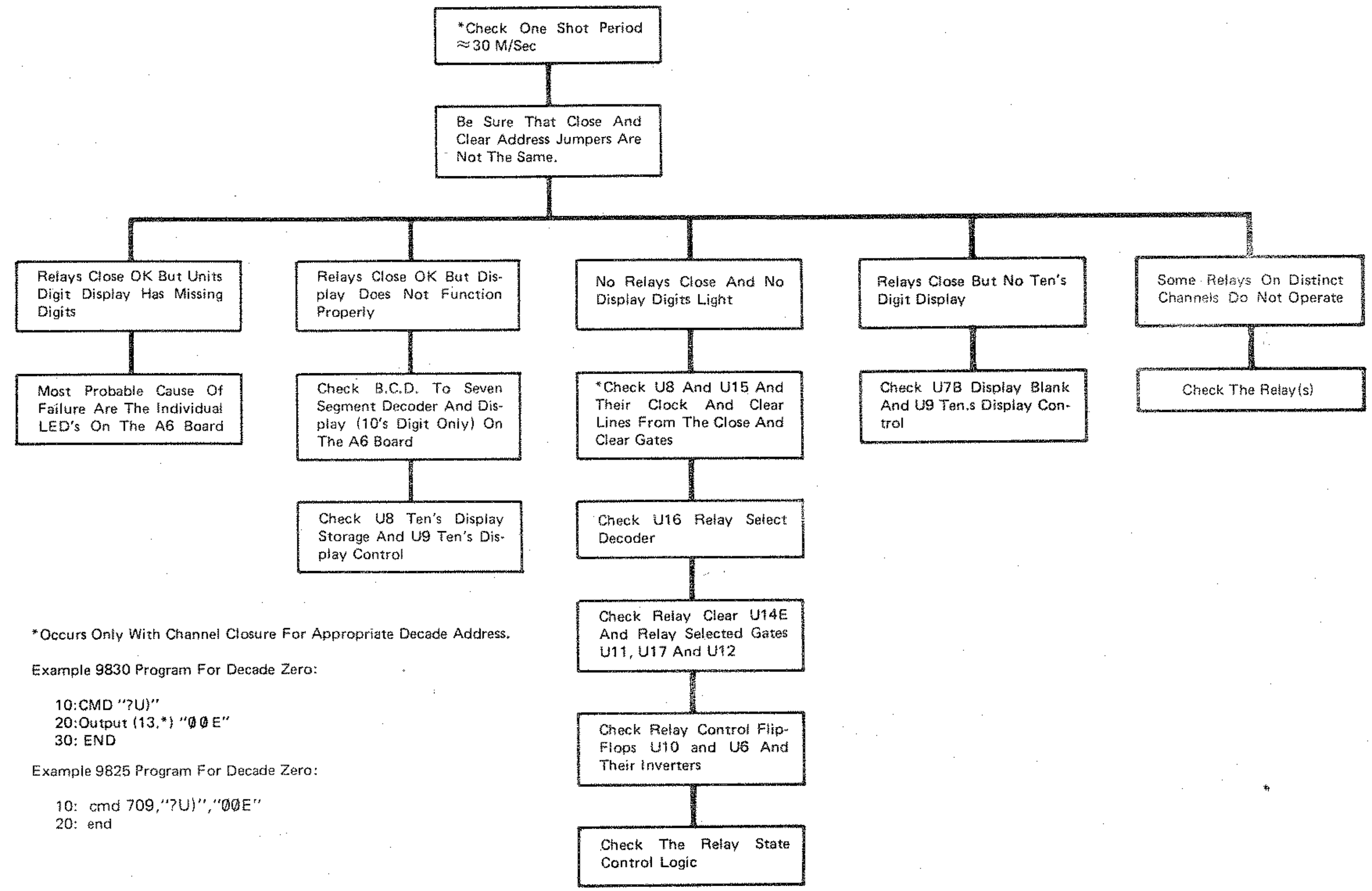
Figure 7-C-3. Actuator State Diagram.

7-C-18. SERVICE MATERIAL.

7-C-19. The following pages include service material for actuator decade assemblies. Included are conventional troubleshooting tree (Figure 7-C-4), replaceable parts lists (Table 7-C-1), SA test procedure flowchart (Figure 7-C-5, A20 component locator (Figure 7-C-6), A20 Block Diagram (Figure 7-C-7), and a schematic (Figure 7-C-8).

Table 7-C-1. Replaceable Parts Actuator Logic A20.

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A20	03495-66520	1 thru 4	ACTUATOR LOGIC ASSY	28480	03495-66520
A20C1	0160-2964		CAPACITOR-FXD .01UF +80-20% 25WVDC CER	28480	0160-2964
A20C2	0160-2964		CAPACITOR-FXD .01UF +80-20% 25WVDC CER	28480	016C-2964
A20C3	0180-0309		CAPACITOR-FXD; 4.7UF+-20% 10VDC TA	56289	150D475X0010A2
A20C4	0160-2964		CAPACITOR-FXD .01UF +80-20% 25WVDC CER	28480	016C-2964
A20C5	0160-2964		CAPACITOR-FXD .01UF +80-20% 25WVDC CER	28480	016C-2964
A20C6	0160-2964		CAPACITOR-FXD .01UF +80-20% 25WVDC CER	28480	0160-2964
A20C7	0160-2964		CAPACITOR-FXD .01UF +80-20% 25WVDC CER	28480	016C-2964
A20C8	0160-2964		CAPACITOR-FXD .01UF +80-20% 25WVDC CER	28480	016C-2964
A20C9	0160-2964		CAPACITOR-FXD .01UF +80-20% 25WVDC CER	28480	016C-2964
A20CR1	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A20R1	1810-0041		CIRCUIT; PSIV; NON-RPRABLE IN	28480	1810-0041
A20R2	1810-0041		CIRCUIT; PSIV; NON-RPRABLE IN	28480	1810-0041
A20R3	0683-2235	1	RESISTOR 22K 5% .25W CC TUBULAR	01121	CB2235
A20R4	0683-3625	1	RESISTOR 3.6K 5% .25W CC TUBULAR	01121	CB3625
A20R5	0684-1031		RESISTOR 10K 10% .25W CC TUBULAR	01121	CB1C31
A20S1	1200-0473		SOCKET; ELEC; IC 16-CONT DIP SLDR TERM	28480	120C-0473
A20S2	1200-0473		SOCKET; ELEC; IC 16-CONT DIP SLDR TERM	28480	120C-0473
A20U1	1820-0704	1	IC DGTL SN74 122 N MULTIVIBRATOR	01295	SN74122N
A20U2	1820-0084	2	IC DGTL SN74 53 N GATE	01295	SN7453N
A20U3	1820-0084		IC DGTL SN74 53 N GATE	01295	SN7453N
A20U4	1820-0070		IC;DGTL;GATE	01295	SN7430N
A20U5	1820-1130	1	IC DGTL SN74S 133 N GATE	01295	SN74S133N
A20U6	1820-0839		IC DGTL SN74 175 N FLIP-FLOP	01295	SN74175N
A20U7	1820-0328		IC;DGTL;GATE	01295	SN7402N
A20U8	1820-0839		IC DGTL SN74 175 N FLIP-FLOP	01295	SN74175N
A20U9	1820-0839		IC DGTL SN74 175 N FLIP-FLOP	01295	SN74175N
A20U10	1820-0788		IC DGTL SN74 174 N FLIP-FLOP	01295	SN74174N
A20U11	1820-1089	3	IC DGTL SN74 279 N LATCH	01295	SN74279N
A20U12	1820-1089		IC DGTL SN74 279 N LATCH	01295	SN74279N
A20U13	1820-0471	2	IC DGTL SN74 06 N INVERTER	01295	SN7406N
A20U14	1820-0471		IC DGTL SN74 06 N INVERTER	01295	SN7406N
A20U15	1820-0839		IC DGTL SN74 175 N FLIP-FLOP	01295	SN74175N
A20U16	1820-0214		IC DGTL SN74 42 N DECODER	01295	SN7442N
A20U17	1820-1089		IC DGTL SN74 279 N LATCH	01295	SN74279N
			A20 MISCELLANEOUS		
	1251-1959		CONNECTOR; PC EDGE; 15-CONT; EXTENDER	71785	251-15-30-380
	1251-3535		CONNECTOR; 16-CONT; MALE; RECTANGULAR	28480	1251-3535
	5000-9043		PIN:P.C. BOARD EXTRACTOR	28480	500C-9043
	5040-6848	1	EXTRACTOR	28480	504C-6848



*Occurs Only With Channel Closure For Appropriate Decade Address.

Example 9830 Program For Decade Zero:

```
10:CMD "?U)"
20:Output (13,*) "00E"
30: END
```

Example 9825 Program For Decade Zero:

```
10: cmd 709,"?U)","00E"
20: end
```

Figure 7-C-4. Actuator Decades Troubleshooting Tree.

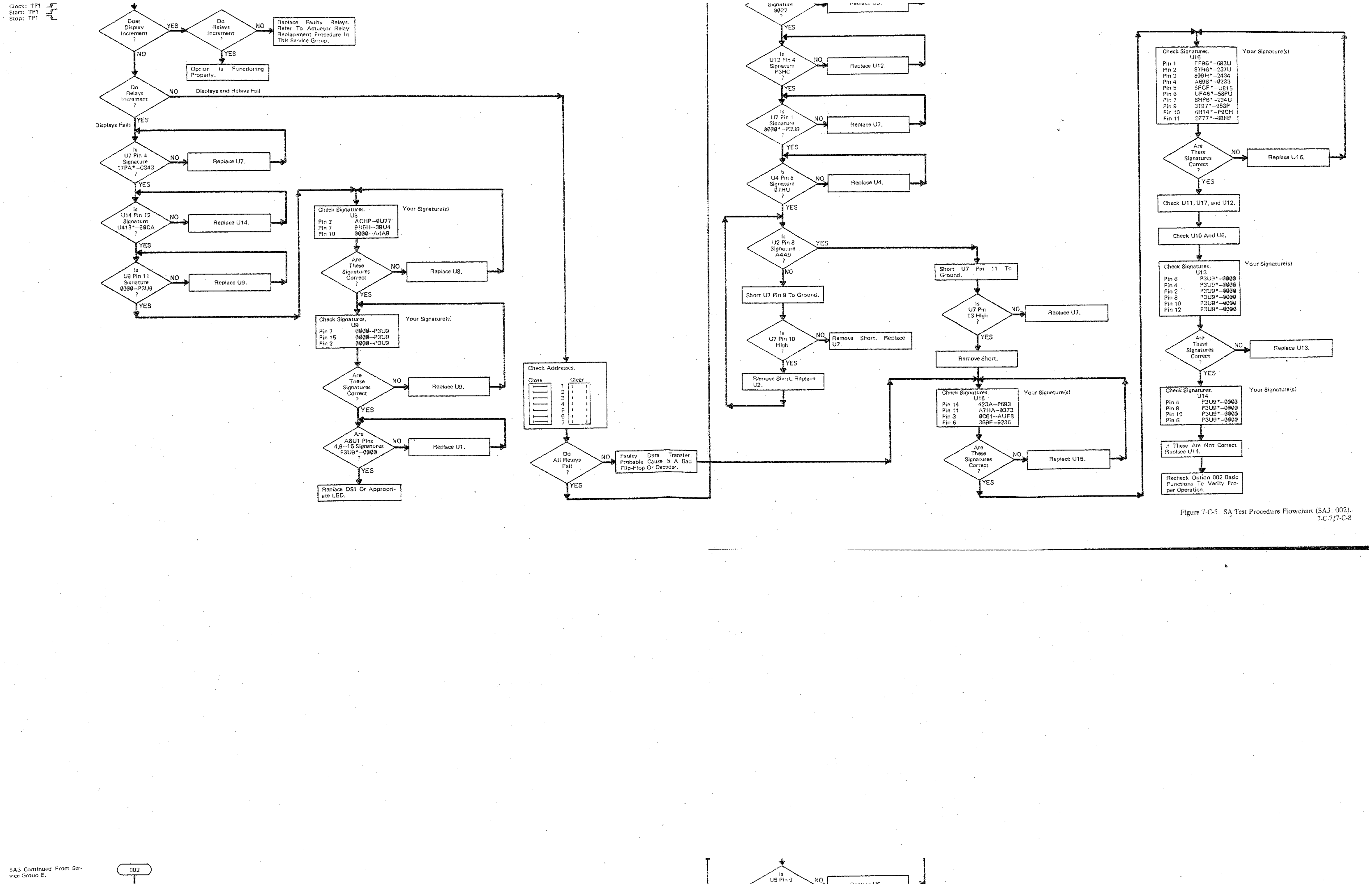
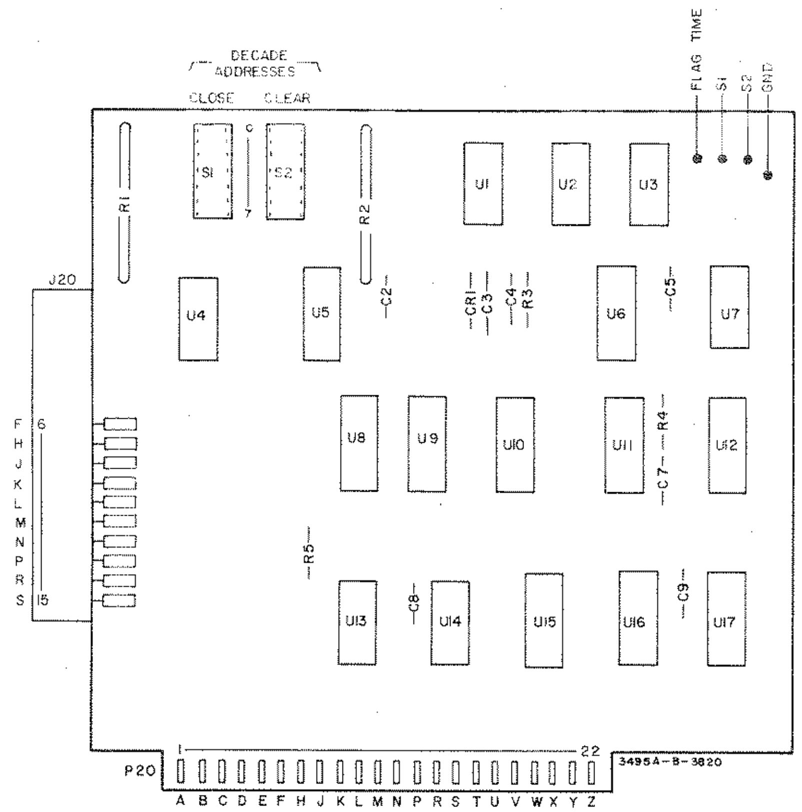


Figure 7-C-5. SA Test Procedure Flowchart (SA3: 002).



A20
hp Part No. 03495-66520
Rev A

Figure 7-C-6. A20 Component Locator.

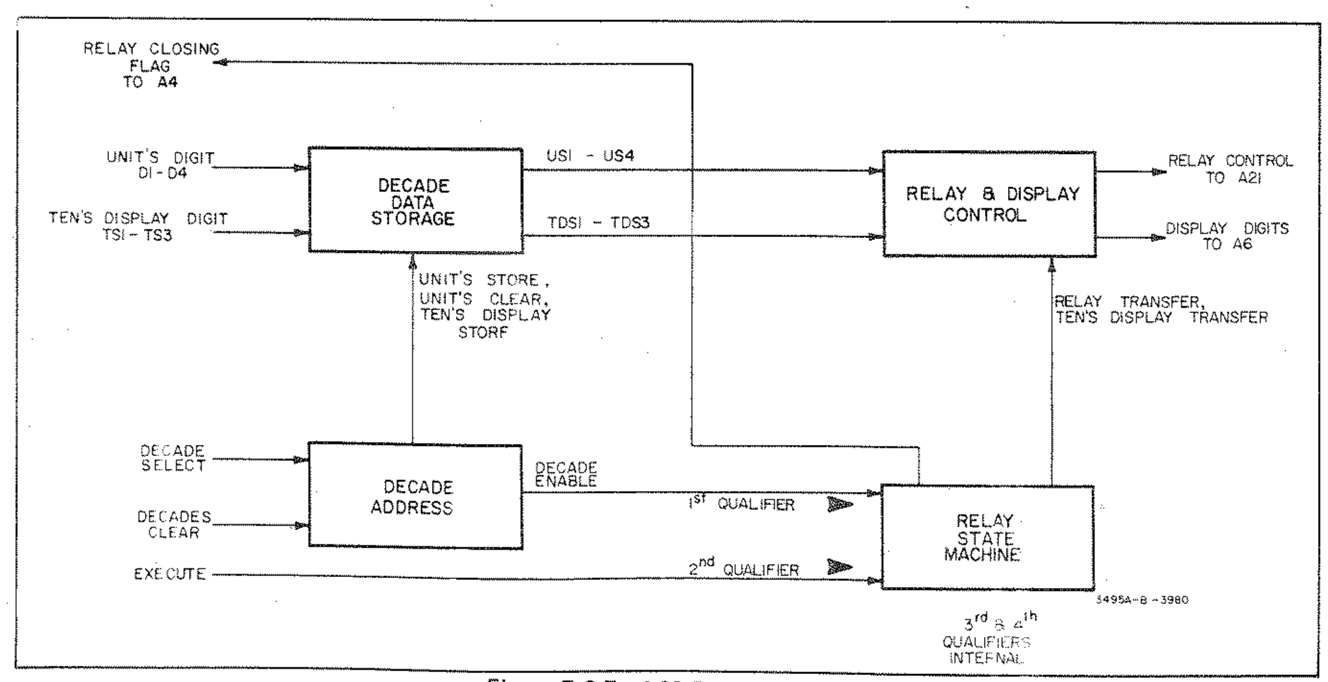


Figure 7-C-7. A20 Block Diagram.

A20

U2

Pin	Signature
2	0022
5	07HU
8	A4A9
10	4750
13	4750

U3

Pin	Signature
1	4750
2	4750

U4

Pin	Signature
1	FH9U
2	U978
8	07HU
11	HAC7
12	P98U

U5

Pin	Signature
9	0022
10	P3HC

U6

Pin	Signature
2	0000*—P3U9
3	P3U9*—0000
4	9H07*—4984
5	AU9C*—4P39
6	P3U9*—0000
7	0000*—P3U9
10	0000*—P3U9
11	P3U9*—0000
12	U318*—53H6
13	2176*—99FF
14	P3U9*—0000
15	0000*—P3U9

U7

Pin	Signature
1	0000*—P3U9
4	17PA*—C343
5	71FF—H565
6	P898—4F31
8	A489
9	A489
10	4750

U8

Pin	Signature
2	ACHP—0U77
3	4827—PF8P
4	HFPA
5	0158
6	7PA4—HA04
7	9H5H—39U4
9	07HU
10	0000—A4A9
11	P3U9—4750
12	5296

U9

Pin	Signature
5	ACHP—0077
6	0000—P3U9
7	0000—P3U9
10	0000—P3U9
11	0000—P3U9
12	17PA—C343
13	39U4—PH5H
14	0000—P3U9
15	0000—P3U9
2	0000—P3U9

U10

Pin	Signature
2	0000*—P3U9
3	50CA*—U413
4	7UH5*—UA6C
5	0000*—P3U9
6	1CUA*—2965
7	0000*—P3U9
10	0000*—P3U9
11	82C8*—1CC6
12	0000*—P3U9
13	3HUH*—29CA
14	789P—25C6
15	0000—P3U9

U11

Pin	Signature
1	U413*—50CA
2	809H*—2434
3	809H*—2434
4	1CUA*—2965
5	U413*—50CA
6	A69A*—0233
7	789P*—25C6
9	50CA*—U413
10	U413*—50CA
11	FF96*—683U
12	FF96*—683U
13	7UH5*—UA6C
14	U413*—50CA
15	87H6*—237U

U12

Pin	Signature
2	0022
3	0022
4	P3HC
5	U413*—50CA
6	2F77*—88HP
7	AU9C*—4P39
9	2176*—99FF
10	U413*—50CA
11	6H14*—F9CH
12	6H14*—F9CH

U13

Pin	Signature
1	0000*—P3U9
2	P3U9*—0000
3	0000*—P3U9
4	P3U9*—0000
5	0000*—P3U9
6	P3U9*—0000
8	P3U9*—0000
9	0000—P3U9
10	P3U9*—0000
11	0000*—P3U9
12	P3U9*—0000
13	0000*—P3U9

U14

Pin	Signature
3	0000*—P3U9
4	P3U9*—0000
5	0000*—P3U9
6	P3U9*—0000
8	P3U9*—0000
9	0000*—P3U9
10	P3U9*—0000
11	0000*—P3U9
12	U413*—50CA
13	17PA*—C343

U15

Pin	Signature
1	P3HC
2	P898—4F31
3	0C61—AUF8
4	CP78
5	2469
6	369F*—9235
7	71FF—H565
9	07HU
10	4423—P08A
11	A7HA—0373
12	AHC5
13	14C3
14	423A—P693
15	056A—A1F3

U16

Pin	Signature
1	FF96*—683U
2	87H6*—237U
3	809H*—2434
4	A698*—0233
5	5FCF*—U815
6	UF46*—58PU
7	8HP6*—294U
9	3197*—953P
10	6H14*—F9CH
11	2F77*—88HP
12	369F*—9235
13	AUF8—0C61
14	0373—A7HA
15	P693—423A

U17

Pin	Signature
1	P3U9
2	3197*—953P
3	3197*—953P
4	U318*—53H6
5	50CA—U413
6	5FCF*—U815
10	U413*—50CA
11	8HP6*—294U
12	8HP6*—294U
13	82C8*—1CC6
14	U413*—50CA
15	UF46*—58PU

A6

U1

Pin	Signature
4	P3U9*—0000
9	P3U9*—0000
10	P3U9*—0000
11	P3U9*—0000
12	P3U9*—0000
13	P3U9*—0000
14	P3U9*—0000
15	P3U9*—0000

*Indicates Predominant Signature

7-C-20. ACTUATOR RELAY REPLACEMENT.

1. Repeat Steps 1–4 of the High/Low Relay replacement procedure (located in Service Group B) to gain access to the Actuator relay board.

2. Unscrew the two screws on each side of the relay board assembly and remove the top cover.

3. Select the correct relay to be removed from the identification chart shown in Figure 7-C-9.

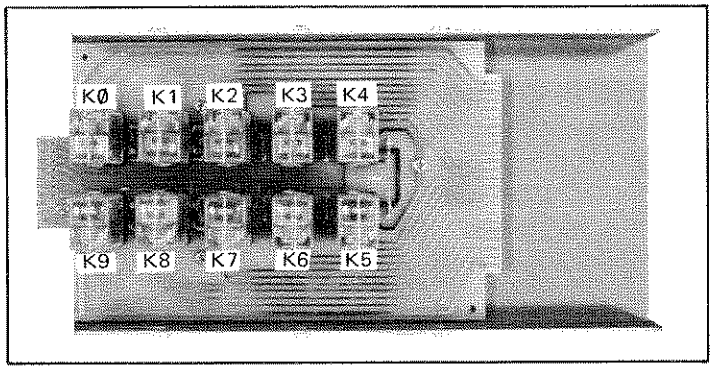


Figure 7-C-9. Actuator Relay Locator.

4. Slide the metal retainer off the relay as shown in Figure 7-C-10.

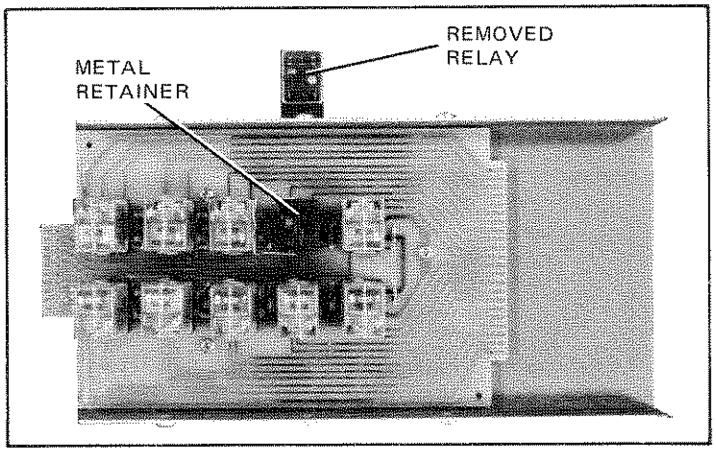


Figure 7-C-10. Actuator Relay Removed from the Board Assembly.

5. Lift up on the relay to remove it from the board.

6. Insert the replacement and slide the metal retainer over the relay.

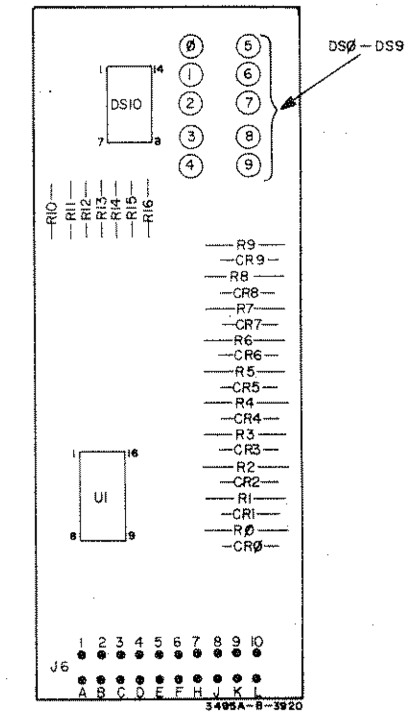
7. Replace the cover and side screws.

8. Insert the Actuator Relay Assembly and Actuator Terminal board into the Scanner. The Relay Assembly should be installed in the same slot it was removed from.

9. Verify that the new actuator relay is operational.

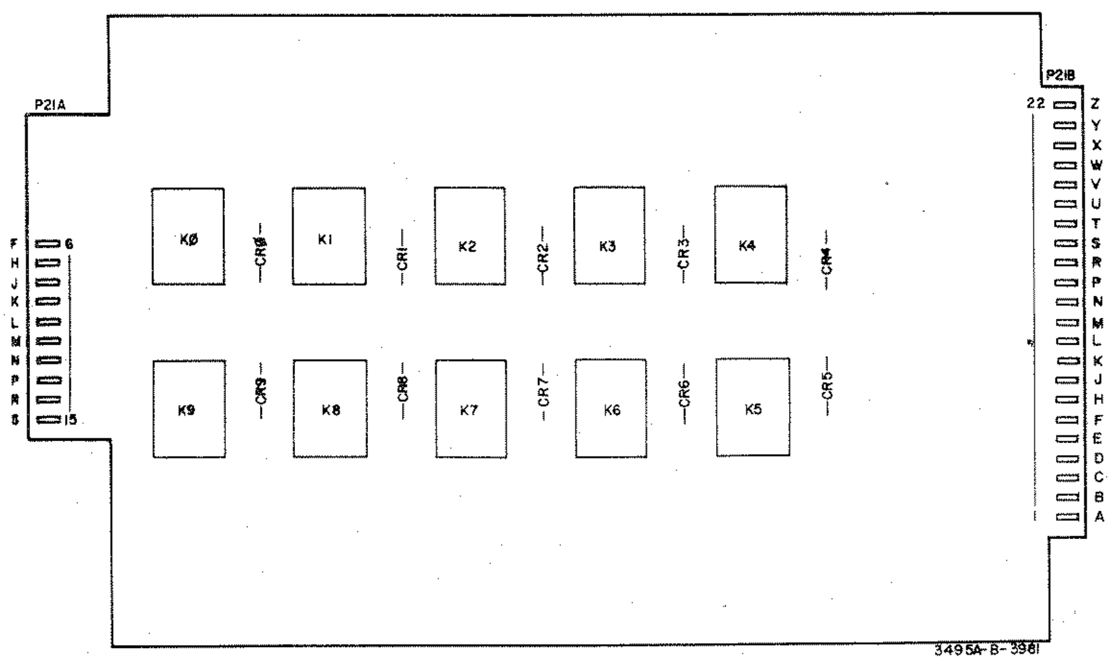
Table 7-C-2. Replaceable Parts Actuator Channel/Display A6, A21, A22, A23.

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A6	03495-66506	1 thru 4	ACTUATOR DISPLAY ASSY	28480	03495-66506
A6CR0	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A6CR1	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A6CR2	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A6CR3	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A6CR4	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A6CR5	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A6CR6	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A6CR7	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A6CR8	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A6CR9	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A6DS0-DS9	1990-0419	10	LED-VISIBLE	28480	1990-0419
A6DS10	1990-0434		DISPLAY NUM SEG 1 CHAR .3 IN HIGH	28480	1990-0434
A6R0	0686-4315	10	RESISTOR 430 OHM 5% .5W CC TUBULAR	01121	EB4315
A6R1	0686-4315		RESISTOR 430 OHM 5% .5W CC TUBULAR	01121	EB4315
A6R2	0686-4315		RESISTOR 430 OHM 5% .5W CC TUBULAR	01121	EB4315
A6R3	0686-4315		RESISTOR 430 OHM 5% .5W CC TUBULAR	01121	EB4315
A6R4	0686-4315		RESISTOR 430 OHM 5% .5W CC TUBULAR	01121	EB4315
A6R5	0686-4315		RESISTOR 430 OHM 5% .5W CC TUBULAR	01121	EB4315
A6R6	0686-4315		RESISTOR 430 OHM 5% .5W CC TUBULAR	01121	EB4315
A6R7	0686-4315		RESISTOR 430 OHM 5% .5W CC TUBULAR	01121	EB4315
A6R8	0686-4315		RESISTOR 430 OHM 5% .5W CC TUBULAR	01121	EB4315
A6R9	0686-4315		RESISTOR 430 OHM 5% .5W CC TUBULAR	01121	EB4315
A6R10	0683-7515		RESISTOR 750 OHM 5% .25W CC TUBULAR	01121	CB7515
A6R11	0683-7515		RESISTOR 750 OHM 5% .25W CC TUBULAR	01121	CB7515
A6R12	0683-7515		RESISTOR 750 OHM 5% .25W CC TUBULAR	01121	CB7515
A6R13	0683-7515		RESISTOR 750 OHM 5% .25W CC TUBULAR	01121	CB7515
A6R14	0683-7515		RESISTOR 750 OHM 5% .25W CC TUBULAR	01121	CB7515
A6R15	0683-7515		RESISTOR 750 OHM 5% .25W CC TUBULAR	01121	CB7515
A6R16	0683-7515		RESISTOR 750 OHM 5% .25W CC TUBULAR	01121	CB7515
A6U1	1820-1233		IC DGTL SN74L 47 N DECODER	01295	SN74L47N
			A6 MISCELLANEOUS		
	03495-87701		ANNUNCIATOR MASK	28480	03495-87701
	03495-87702		ANNUNCIATOR MASK	28480	03495-87702
	1200-0474		SOCKET; ELEC; IC 14-CONT DIP SLDR TERM	28480	1200-0474
	1251-2034		CONNECTOR; PC EDGE; 10-CONT; DIP SOLDER	71785	252-10-30-300
	5040-5839	2	HOUSING, ANNUNCIATOR	28480	5040-5839
A21	03495-66521	1 thru 4	ACTUATOR RELAY ASSY	28480	03495-66521
A21CR0	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A21CR1	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A21CR2	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A21CR3	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A21CR4	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A21CR5	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A21CR6	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A21CR7	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A21CR8	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A21CR9	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A21K0	0490-0563	10	RELAY; 12VAC; CONT 5A 115VDC FORM 2C	28480	0490-0563
	0490-0568	10	SOCKET, RELAY	28480	0490-0568
A21K1	0490-0563		RELAY; 12VAC; CONT 5A 115VDC FORM 2C	28480	0490-0563
	0490-0568		SOCKET, RELAY	28480	0490-0568
A21K2	0490-0563		RELAY; 12VAC; CONT 5A 115VDC FORM 2C	28480	0490-0563
	0490-0568		SOCKET, RELAY	28480	0490-0568
A21K3	0490-0563		RELAY; 12VAC; CONT 5A 115VDC FORM 2C	28480	0490-0563
	0490-0568		SOCKET, RELAY	28480	0490-0568
A21K4	0490-0563		RELAY; 12VAC; CONT 5A 115VDC FORM 2C	28480	0490-0563
	0490-0568		SOCKET, RELAY	28480	0490-0568
A21K5	0490-0563		RELAY; 12VAC; CONT 5A 115VDC FORM 2C	28480	0490-0563
	0490-0568		SOCKET, RELAY	28480	0490-0568
A21K6	0490-0563		RELAY; 12VAC; CONT 5A 115VDC FORM 2C	28480	0490-0563
	0490-0568		SOCKET, RELAY	28480	0490-0568
A21K7	0490-0563		RELAY; 12VAC; CONT 5A 115VDC FORM 2C	28480	0490-0563
	0490-0568		SOCKET, RELAY	28480	0490-0568
A21K8	0490-0563		RELAY; 12VAC; CONT 5A 115VDC FORM 2C	28480	0490-0563
	0490-0568		SOCKET, RELAY	28480	0490-0568
A21K9	0490-0563		RELAY; 12VAC; CONT 5A 115VDC FORM 2C	28480	0490-0563
	0490-0568		SOCKET, RELAY	28480	0490-0568
A22	NONE	1 thru 4	ACTUATOR CHANNEL ASSY		
A22A21	03495-66521		ASSEMBLY	28480	03495-66521
A23	03495-64102	1 thru 4	ACTUATOR TERMINAL ASSY	28480	03495-64102



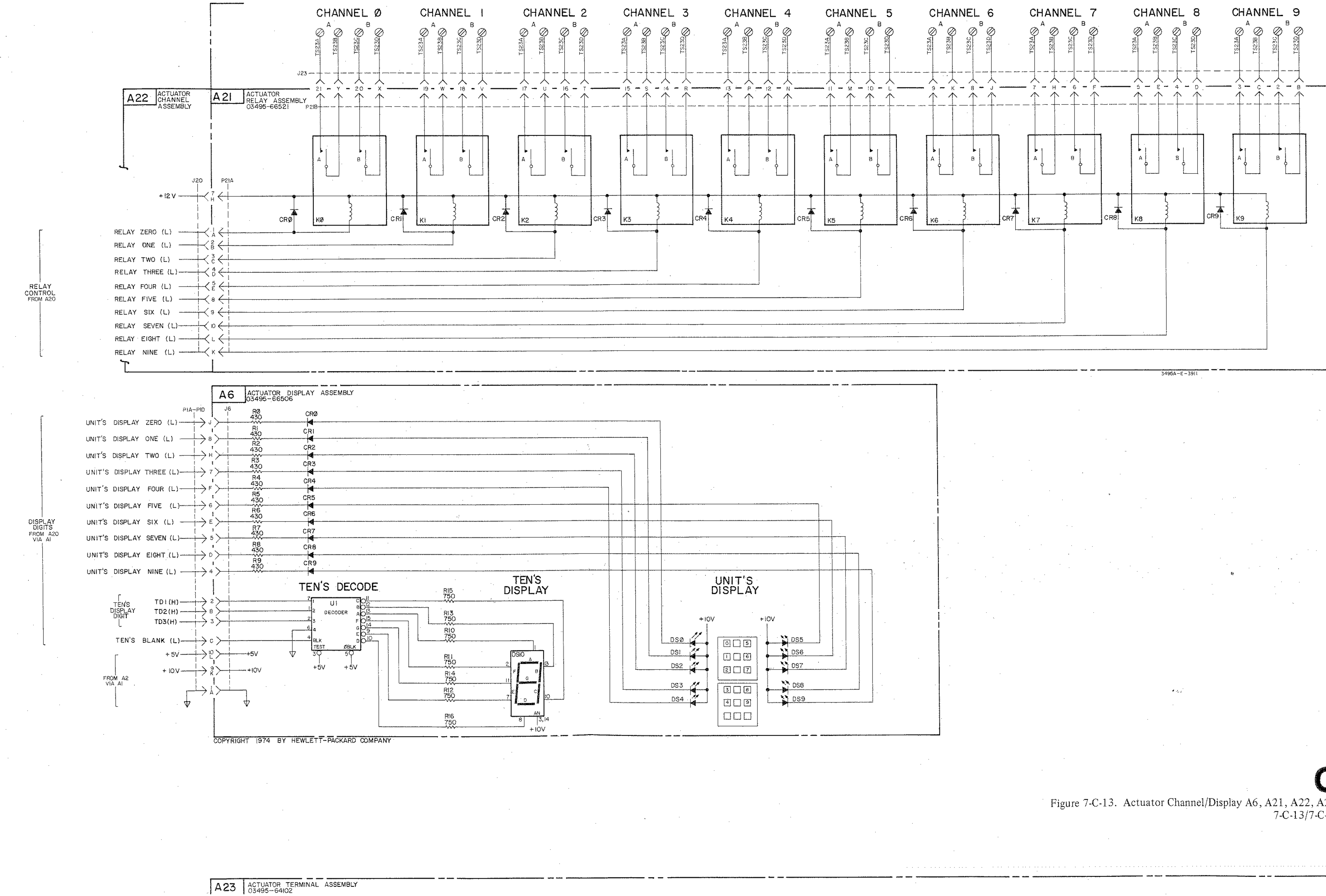
A6
hp Part No. 03495-66506

Figure 7-C-11. A6 Component Locator.



A21
hp Part No. 03495-66521
Rev A

Figure 7-C-12. A21 Component Locator.



C

Figure 7-C-13. Actuator Channel/Display A6, A21, A22, A23.

SERVICE GROUP D
LOW–THERMAL DUO–DECADES
OPTIONS 004 AND 005/ACCESSORIES 44404A AND 44405A

Service Group D contains theory and information for low thermal duo-decade scanner channel options. Each option 004 contains 20 measurement channels. Channel Ø of option 005 monitors the connector temperature with a thermistor. The remaining 19 channels are available for thermocouple connections.

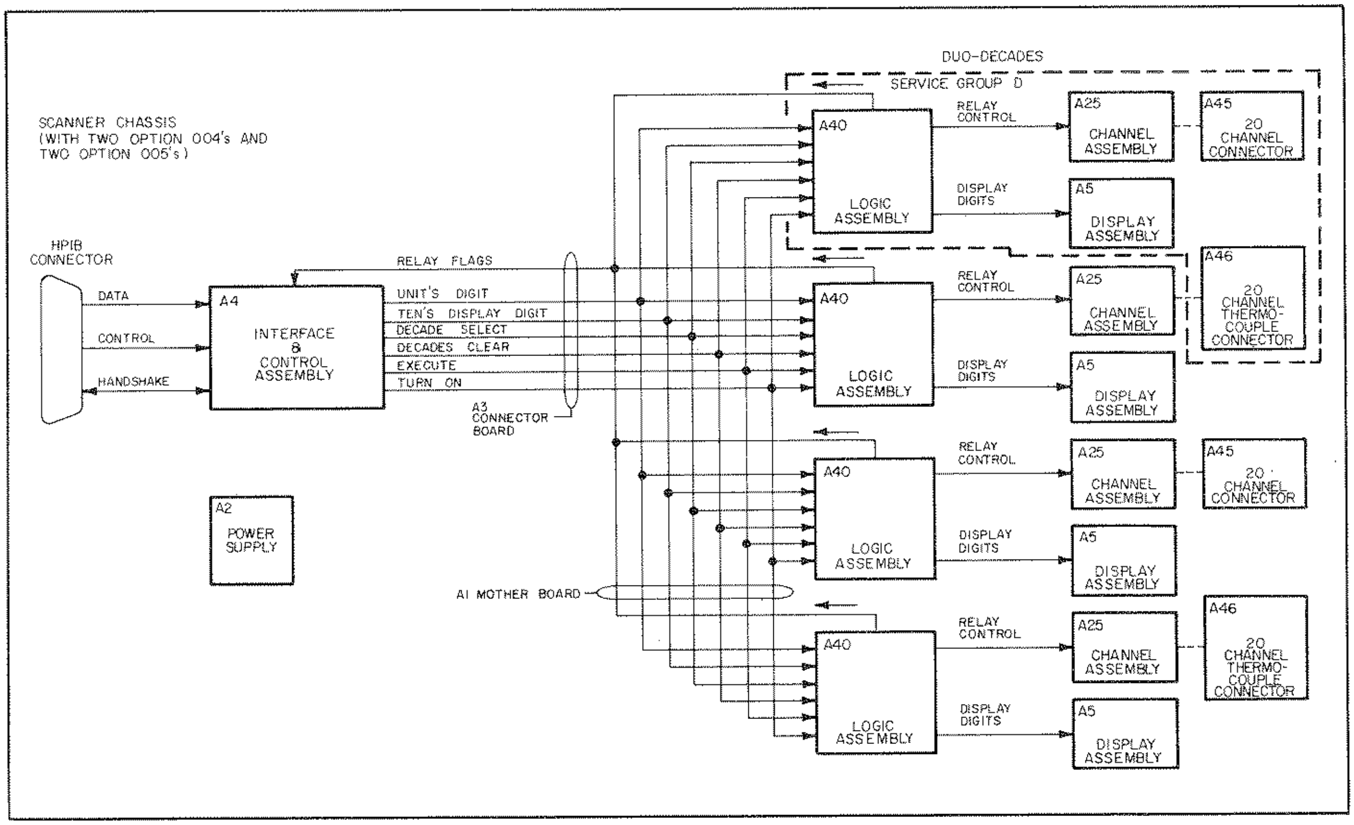


Figure 7-D-1. Service Group D.

Service information on the following assemblies is in this service group.

- A40 20 Channel Logic Assembly
- A25 20 Channel Assembly
- A45 20 Channel Connector (with Option 004)
- A46 20 Channel Thermocouple Connector (with Option 005)
- A5 Display Assembly

7-D-1. The low thermal duo-decade options are twenty-to-one multiplexers. The additional assemblies covered in this service group are the A5 display assembly, A10 logic assembly, A25 channel assembly, and A45 or A46 terminal connectors.

7-D-2. The A46 duo-decade reference connector assembly in Option 005 replaces the terminal assembly of Option 004. The duo-decade reference connector minimizes temperature differences between each channel and the terminals within each channel. A thermistor is used to monitor the temperature of the terminal. This value is then used to adjust thermocouple voltages. The adjusted voltages can then be converted into accurate temperature measurements. The compensation procedure is discussed in Section III, Applications.

7-D-3. Information in this service group is presented as follows:

a. Theory of Operation
b. Servicing Aids
c. Servicing Procedures
d. Service Material

A40: THEORY OF OPERATION

7-D-4. INTRODUCTION.

7-D-5. The A40 duo-decade logic assembly receives channel instructions from the interface and control assembly and controls the relay and display assemblies. The A40 logic is initialized by instrument turn-on, and relay activity begins on an Execute signal from the interface and control assembly. The A40 logic assembly provides A5 display data and control and A25 relay control and drive current.

7-D-6. DUO–DECADE ADDRESS BLOCK.

7-D-7. The dip switch (S1) positions determine the close and open addresses for the A40 logic assembly. The possible duo-decade addresses are Ø, 2, 4 and 6. Positioning the dip switches is illustrated in Section III, Hardware Programming. The address selection determines which channel instructions the relays close on and which decade instructions they open on.

NOTE

An open address overrides a close address.

7-D-8. The Decade Close (DC) signal stores the channel programming instruction in the data storage block and clocks the logic delay block which delays the decade close (DC) signal to the close timer (establishes open priority and break-before-make synchronization).

7-D-9. The Decade Open (DO) signal or the Clear signal from the interface and control assembly will clear all units digits from the data storage block to an invalid digit of 15 which blanks the display and opens all the duo-decade relays. The decade open or clear signals also initiates the open timer sequence (through the logic delay block).

7-D-10. DATA STORAGE BLOCK.

7-D-11. The data storage block stores the channel ten's and unit's digits from the interface and control assembly upon the decade close signal from the duo-decade address block. The unit's storage flip-flop is cleared to an invalid digit of 15 by the decade open or clear signals.

7-D-12. LOGIC DELAY BLOCK.

7-D-13. The logic delay block provides a small delay (about 15 microseconds) on the

decade close signal. This small delay establishes the open timer priority and break-before-make synchronization, since the decade close signal also gates the open timer.

7-D-14. TIMER BLOCK.

7-D-15. The timer block establishes the open and close intervals in which relays are instructed to open and close. The open cycle precedes the close cycle and is shorter in duration (220 microseconds compared to 666 microseconds). A channel close instruction initiates an open interval followed by a close interval. A duo-decade open instruction initiates only an open interval.

7-D-16. The open timer interval is initiated by the decade open signal "and" and execute, or a decade close signal "and" an execute. The open timer signal then holds the delayed decade close signal until the open timer interval has ended. The end of the open timer interval clears the decade open signal.

7-D-17. The delayed close signal is then gated to the close timer which begins the close timer interval. The close timer interval has been determined by the physical properties or the relays used. The interval must be long enough to allow all relays to close and a reliable measurement to be made. This includes time to eliminate relay bounce and coil loading and repeatability effects. The close timer and opening flag signals are used to clock the unit's display and ten's display data into the relay and display control flip-flops.

7-D-18. The instant relays open is dependent upon switching speed. In general, switching times less than 1.6 msec cause the relays to open outside the open timer interval.

7-D-19. The instant relays close is dependent upon switching time and relay current. In general, higher switching speeds and more current increase the time to close.

7-D-20. The open and close timers are cleared by instrument turn-on. The logic delay, open, and close timers are R—C selectable and easily modified.

NOTE

Although easily modified, the factory R–C values were selected to guarantee minimal noise and a switching time under one (1) millisecond. Modifications to these values represent modifications to performance.

7-D-21. RELAY AND DISPLAY CONTROL BLOCK.

7-D-22. The relay and display control block functions as a BCD-to-decimal-decoder with a common driver and supplies BCD data to the displays.

7-D-23. Data from the display control flip-flops is passed to the displays and serves as input to the relay select circuitry. The relay select circuitry is a one-out-of-twenty decoder which sinks current through the selected relay coil.

7-D-24. The source for the relay current is a two-level relay coil drive circuit consisting of current sources Q1 and Q2. Q2 supplies the steady-state relay holding current and is controlled by the close timer (CT) signal. Q1 supplies additional switching current during the open timer (OT) interval.

7-D-25. DETAILED OPERATIONAL DESCRIPTION.

7-D-26. U7 serves as duo-decade address select decoder by logically "or"ing the decade select lines in pairs. This establishes 4 duo-decade address possibilities of 00 through 19, 20 through 39, 40 through 59, and 60 through 79. Switch S1 implements a low true "and" operation between the duo-decade select signals and the selected option CLOSE and OPEN addresses.

7-D-27. Upon a CLOSE address, U14B sets the decade close signal high, which latches the unit's digit and ten's digit information from the A4 or A8 controller assembly. The dc signal also clocks the U15A decade close flip-flop, setting the dc signal at TP4. An "execute" signal gates DC through U17D to the U16B open timer, initializing the open timer interval (the length of which is determined by R13 x C6).

7-D-28. The open timer (OT) signal latches the unit's digit and ten's digit information into U12 and U10 respectively, providing a second level of storage. The OT signal also disables the delayed DC signal at U13B. The execute signal also gates the DC signal through a logic delay determined by R14 x C8. The open timer (OT) signal performs several functions to the U16A close timer:

a. Clears the unit's digit flip-flop and clocks the ten's digit flip-flop, U12 and U10 respectively.

b. Generates the opening flag (OF) signal to the controller assembly.

c. Holds the delayed DC signal to the U16 close timer at Gate U13B.

d. Clears the U15A decade close flip-flop.

e. Provides basic drive for the Q1 (initially off) relay coil drive current source.

7-D-29. Clearing the relay select circuitry removes any current paths through the relay coils, which causes all relays to open. The gating at U13B is common to all options in the 3495A. Thus, OF serves as a pacing signal to limit the transfer speed of channel data to the SLOWEST option installed with an open (clear) address.

NOTE

This is important when mixed options are used and high speed capability is expected. Always remove any CLEAR addresses from slower options in this case.

7-D-30. Holding the DC signal at U13 creates break-before-make synchronization by implementing the open timer interval *before* the close timer interval. The decade close flip-flop is cleared to re-initialize the sequence and recharge C8. Q2 is initially on and serves as a steady-state relay coil current source. Q1 provides the transient or switching relay coil current at the beginning of the close timer interval.

7-D-31. The open timer interval lasts approximately 22 milliseconds. When OT goes low, the DC signal held at U13B is gated to the U16A close timer, implementing the close timer (CT) interval. At this point, the CT signal performs the following:

a. Clocks data through the U12 unit's digit flip-flop.

b. Generates the closing flag (CF) signal to the controller assembly.

c. Clears the U15B decade open flip-flop.

d. Reduces base drive on the Q2 steady state relay coil drive current source (reduces steady-state power demands).

7-D-32. OT remains low and CT remains high until another DC or DO signal and an "execute" are present.

7-D-33. Upon an OPEN address, U14A sets the decade open signal high. This signal or a "clear" signal sets the U9 unit's storage flip-flop. This creates an invalid digit code which is derived by U17C. This signal is later used to blank the displays.

7-D-34. The decade open signal or the "clear" signal also clocks the U15B decade open flip-flop, thus setting DO at TP5. The DO signal is gated to the U16B open timer by an "execute" signal, implementing the open timer (OT) interval. The sequence from here on is similar to that caused by a decade close address, except that the DC signal is not present and thus the close timer interval is not implemented in this cycle.

7-D-35. The invalid digit signal created by the decade open or clear signal is gated to the display during the open timer interval to act as an immediate blanking signal.

7-D-36. The relay select circuitry is a one-of-twenty decoder. Decoding is arranged in groups of Ø through 6, 7 through 13, and 14 through 19.

7-D-37. CHANNEL CONSIDERATIONS.

7-D-38. The A42 reed board was designed to minimize temperature differences between relay contacts and between channel relays through multi-layer cladded boards. A thermally insulating board separates the coil board to reduce heat transfer from the coils. The A22 sheet metal assembly and internal scanner chassis help reduce heat transfer from convection.

7-D-39. The A45 and A46 connector assemblies both employ multi-layer PC board cladding to reduce the temperature difference between terminals. The overall effect is a low thermal offset characteristic and a small temperature gradient between terminals.

7-D-40. For most measurement applications where relay loading is minimal, the maximum switching rate of 1000 channels/second applies without reservation. However, the high speed capability of duo-decade channels is advised for burst measurements only.

NOTE

Extensive use of high speed channel switching places wear on the A42 reed relays. Reed life is a function of both reed closures and current loading.

7-D-41. The following guidelines should be used to insure proper switching performance and maximize the life of your reeds:

a. Do not prolong high-speed switching under heavy loading.

b. Minimize switching transients through insertion of proper series resistors on each channel to be switched. This current limiting will protect your reeds from surges which can be generated as the channel capacitance charges through low impedance sources. An example may help.

Example: Switching a 42 volt source requires current limiting to 24 mA to meet the 1 VA specified product. This means inserting an 875 ohm resistor in each High and Low line (1750 total). The result is a .0175% possible measurement error when compared to the 10 megohm channel impedance and assuming an open circuit measurement instrument.

7-D-42. RELAY CLOSURE SEQUENCE.

7-D-43. Refer to Figure 7-D-2, timing relationships. The relay closure sequence is as follows:

a. A valid channel close instruction is received and latched into the data storage flip-flops by an Execute signal.

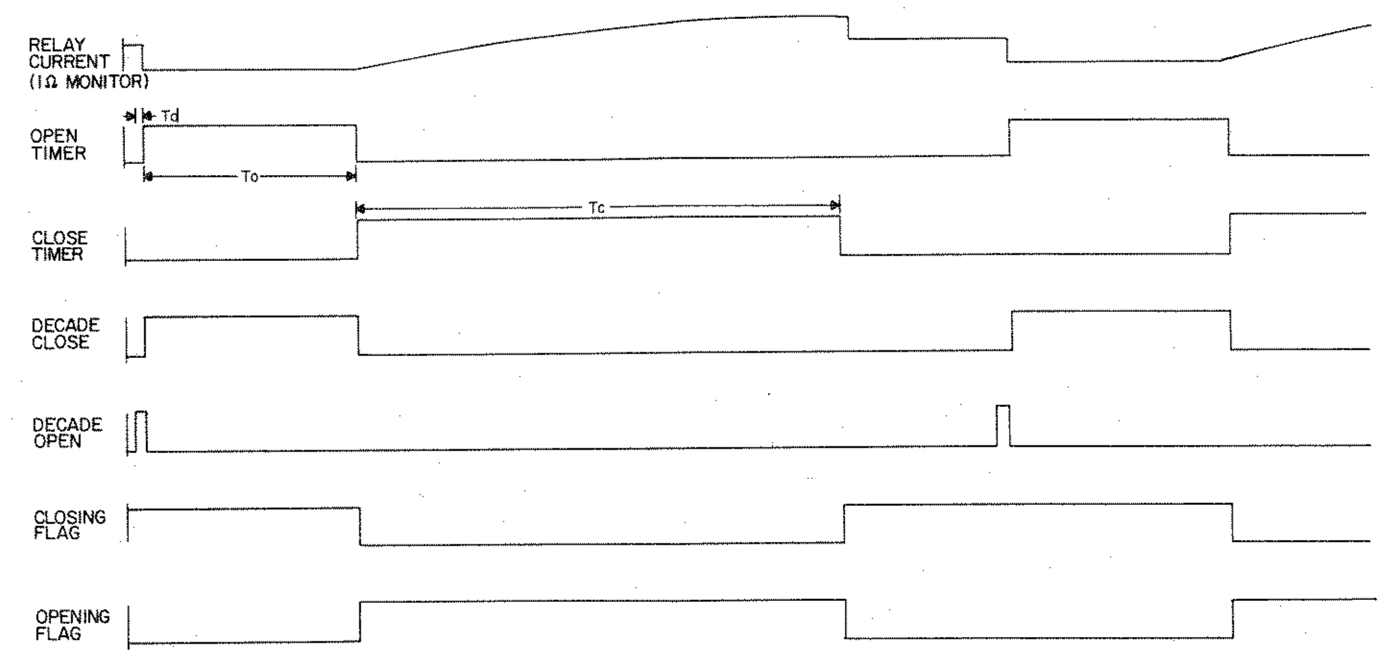


Figure 7-D-2. A40 Timing Relationships.

b. The logic delay timer delays relay selection by implementing the Open Timer Interval and holding the Decade Close Signal to the Close Timer.

NOTE

The open timer signal also clears the decade close flip-flop.

c. The Opening Flag signal is detected by the interface and control assembly which halts the transfer of data to the logic assembly until the relay has opened.

d. The Open Timer Interval ends, gating the Close Timer and implementing the Close Timer Interval.

e. The Close Timer signal gates the relay and display control flip-flops which select the proper relay (through the Relay Select circuitry) and provide display data.

NOTE

The Close Timer signal also clears the decade open flip-flop.

f. The Closing Flag signal is detected by the interface and control assembly which then provides more data to the logic assembly and prepares the sequence again.

g. Current from the Relay Coil Drive circuit is sinked through the selected relay coil which causes the relay to close.

h. The Close Timer interval ends and the sequence can repeat.

7-D-44. SERVICING PROCEDURES.

7-D-45. If a faulty reed relay or relay coil is located, the assembly may be repaired by replacing the component or by obtaining replacement boards from your local -hp- Sales and Service Office.

CAUTION

The A41 and A42 PC assemblies require clean handling techniques. Use gloves when servicing these assemblies to avoid degrading channel impedances.

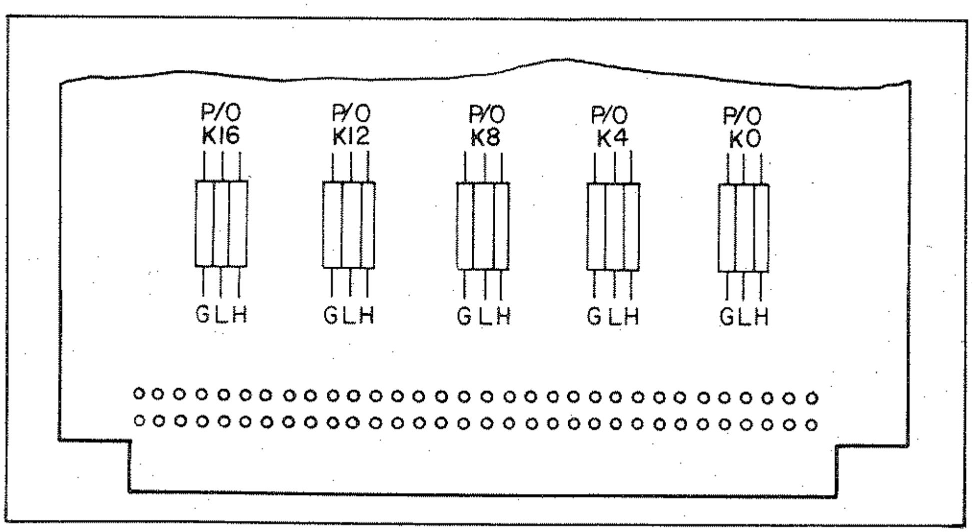


Figure 7-D-3. A42 Relay Connection Guide.

7-D-46. Replacing the relay board is advised to insure proper low-thermal operation and reed life. The coils may be replaced without affecting low thermal operation. Part numbers for these components and boards are in the replaceable parts list of this service group.

7-D-47. Plated-through holes are available on the A42 relay assembly for use in monitoring the relay connections or for permanent connection of measurement wires. The location and assignment of these holes is shown in Figure 7-D-3.

7-D-48. The reed and coil channel assignments are etched onto the A41 and A42 assemblies to aid in reed and coil replacement.

NOTE

Here again, reed replacement is advised at a board level.

7-D-49. SERVICE MATERIAL.

7-D-50. The following pages contain service material for the duo-decade assemblies. Included is an A40 Troubleshooting Tree (Figure 7-D-4), SA Test Procedure Flowchart (Figure 7-D-5), an A40 component locator (Figure 7-D-6), an A40 block diagram (Figure 7-D-7), replaceable parts lists (Tables 7-D-1 and 7-D-2), and schematics (Figures 7-D-8 and 7-D-9).

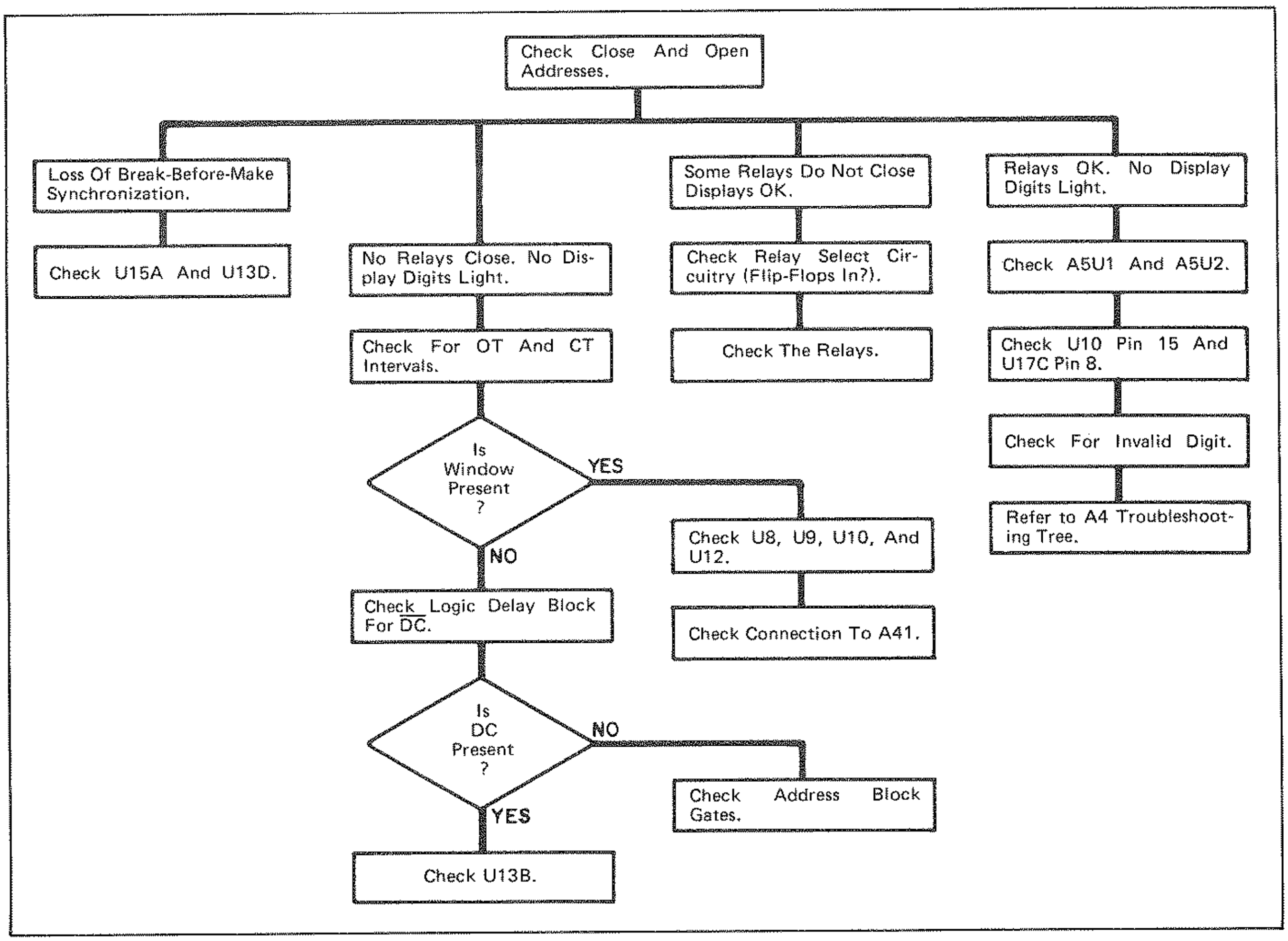
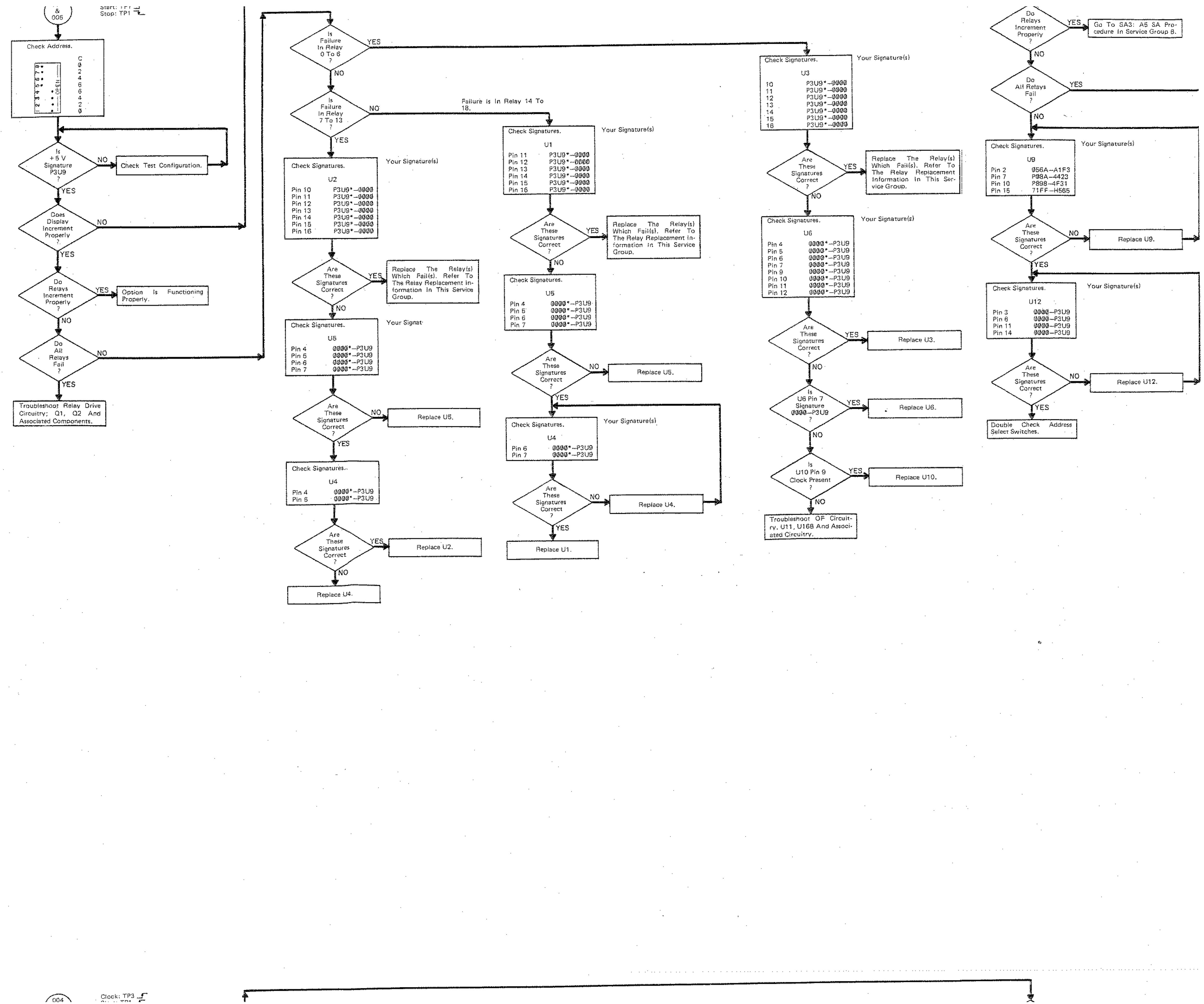


Figure 7-D-4. 3495A Duo-Decades Troubleshooting Tree.

Table 7-D-1. Replaceable Parts.

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
			LOW THERMAL LOGIC ASSEMBLY (OPTIONS 004 and 005)		
A40	03495-66540	1	PC ASSY LOGIC	28480	03495-66540
A40C1–3	0160-2055	6	CAP–FXD .01 μF 100 V	28480	0160-2055
A40C4	0160-3017	2	CAP–FXD .015 μF .05	28480	0160-3017
A40C5	0160-2055		CAP–FXD .01 μF 100 V	28480	0160-2055
A40C6	0160-3017		CAP–FXD .015 μF .05	28480	0160-3017
A40C7	0160-2055		CAP–FXD .01 μF 100 V	28480	0160-2055
A40C8	0160-0194	1	CAP–FXD 15,000 pF 200 V	04200	292P15392
A40C9	0160-2055		CAP–FXD .01 μF 100 V	28480	0160-2055
A40CR1	1901-0040	2	DIO–SI .05 A 30 V	28480	1901-0040
A40CR2	1902-0554	1	DIO ZNR BKDN 10 V 5%	28480	1902-0554
A40CR3	1901-0045	1	DIO–SI .75 A 100 V	02713	MP497
A40CR4	1901-0040		DIO–SI .05 A 30 V	28480	1901-0040
A40J40	1251-1959	1	CONN–PC 30(2X15) EA	04507	251-15-30-380
A40Q1, 2	1853-0012	2	XSTR–PNP	01698	2N2904A
A40R1	0683-5115	1	RES–FXD 510 Ω .05 .25 W	01607	CB5115
A40R2	0683-1305	1	RES–FXD 13 Ω .005 .25 W	01607	CB1305
A40R3	0683-0335	1	RES–FXD 3.3 Ω .05 .25 W	01607	CB33G5
A40R4	0683-1315	1	RES–FXD 130 Ω .25 W 5%	01607	CB1315
A40R5	0683-3915	3	RES–FXD 390 Ω .05 .25 W	01607	CB3915
A40R6, 7	0683-1035	4	RES–FXD 10 K .05 .25 W	01607	CB1035
A40R8	0683-3915		RES–FXD 390 Ω .05 .25 W	01607	CB3915
A40R9	1810-0041	1	RES–NETWORK 9–PIN–SIP .15 PIN–SPCG	28480	1810-0041
A40R10, 11	0683-1035		RES–FXD 10 kΩ .05 .25W	01607	CB1035
A40R12			PAD VALUE (RES–FXD)		
	0757-0460		61.9 K 1%	03292	C4-1/8-T0-6192-F
	0698-3280		63.4 K 1%	28480	0698-3280
	0757-3572		60.4 K 1%	28480	0757-3572
A40R13			PAD VALUE (RES–FXD)		
	0757-1999		21.5 K 1%	28480	0757-1999
	0757-0449		20.0 K 1%	03292	C4-1/8-T0-2002-F
	0757-4485		23.2 K 1%	28480	0757-4485
A40R14	0683-3915	1	RES–FXD 390 Ω .05 .25	01607	CB3915
A40S1	3101-2094	1	SW–TGL ASSY–ROCKER	04990	76B08-RED
A40U1–3	1858-0047	3	XSTR ARRAY DA PIN	28480	1858-0047
A40U4–6	1820-1729	3	IC TTL LATCH	01698	SN74LS259N
A40U7	1820-1201	2	IC–GATE TTL LS AND QUAD 2–INP	01698	SN74LS08N
A40U8–10	1820-1195	5	IC–FF TTL LSD–TYPE	01698	SN74LS175N
A40U11	1820-0577	1	IC–INV TTL HEX I–INP	01698	SN7416N
A40U12	1820-1195		IC FF TTL LS D–TYPE	01698	SN74LS175N
A40U13	1820-1201		IC–GATE TTL LS AND QUAD 2–INP	01698	SN74LS08N
A40U14	1820-1204	1	IC–GATE TTL LS	01698	SN74LS20N
A40U15	1820-1212	1	IC–FF TTL LS J–K NEG–EDGE–TRIG	01698	SN74LS112N
A40U16	1820-1437	1	IC–MU TTL LS MONOSTBL DUAL	01698	SN74LS221N
A40U17	1820-1208	1	IC–NAND DUAL 4–INP	01698	SN74LS32N
A40U18	1820-1415	1	IC SCHMITT–TRIG TTL LS NAND	01698	SN74LS13N



& 005
Start: TP1
Stop: TP1
Check Address.
OPEN
C
0
2
4
6
6
4
2
0
Is +5 V Signature P3U9 ?
NO
Check Test Configuration.
YES
Does Display Increment Properly ?
NO
YES
Do Relays Increment Properly ?
YES
Option Is Functioning Properly.
NO
Do All Relays Fail ?
NO
YES
Troubleshoot Relay Drive Circuitry; Q1, Q2 And Associated Components.
Is Failure In Relay 0 To 6 ?
YES
NO
Is Failure In Relay 7 To 13 ?
NO
Failure Is In Relay 14 To 18.
YES
Check Signatures.
U2
Pin 10 P3U9*–0000
Pin 11 P3U9*–0000
Pin 12 P3U9*–0000
Pin 13 P3U9*–0000
Pin 14 P3U9*–0000
Pin 15 P3U9*–0000
Pin 16 P3U9*–0000
Your Signature(s)
Are These Signatures Correct ?
YES
Replace The Relay(s) Which Fail(s). Refer To The Relay Replacement Information In This Service Group.
NO
Check Signatures.
U5
Pin 4 0000*–P3U9
Pin 5 0000*–P3U9
Pin 6 0000*–P3U9
Pin 7 0000*–P3U9
Your Signat
Are These Signatures Correct ?
NO
Replace U5.
YES
Check Signatures.
U4
Pin 4 0000*–P3U9
Pin 5 0000*–P3U9
Are These Signatures Correct ?
YES
Replace U2.
NO
Replace U4.
Check Signatures.
U1
Pin 11 P3U9*–0000
Pin 12 P3U9*–0000
Pin 13 P3U9*–0000
Pin 14 P3U9*–0000
Pin 15 P3U9*–0000
Pin 16 P3U9*–0000
Your Signature(s)
Are These Signatures Correct ?
YES
Replace The Relay(s) Which Fail(s). Refer To The Relay Replacement Information In This Service Group.
NO
Check Signatures.
U5
Pin 4 0000*–P3U9
Pin 5 0000*–P3U9
Pin 6 0000*–P3U9
Pin 7 0000*–P3U9
Are These Signatures Correct ?
NO
Replace U5.
YES
Check Signatures.
U4
Pin 6 0000*–P3U9
Pin 7 0000*–P3U9
Your Signature(s)
Are These Signatures Correct ?
NO
Replace U4.
YES
Replace U1.
Check Signatures.
U3
10 P3U9*–0000
11 P3U9*–0000
12 P3U9*–0000
13 P3U9*–0000
14 P3U9*–0000
15 P3U9*–0000
16 P3U9*–0000
Your Signature(s)
Are These Signatures Correct ?
YES
Replace The Relay(s) Which Fail(s). Refer To The Relay Replacement Information In This Service Group.
NO
Check Signatures.
U6
Pin 4 0000*–P3U9
Pin 5 0000*–P3U9
Pin 6 0000*–P3U9
Pin 7 0000*–P3U9
Pin 9 0000*–P3U9
Pin 10 0000*–P3U9
Pin 11 0000*–P3U9
Pin 12 0000*–P3U9
Your Signature(s)
Are These Signatures Correct ?
YES
Replace U3.
NO
Is U6 Pin 7 Signature 0000–P3U9 ?
YES
Replace U6.
NO
Is U10 Pin 9 Clock Present ?
YES
Replace U10.
NO
Troubleshoot OF Circuitry, U11, U16B And Associated Circuitry.
Do Relays Increment Properly ?
YES
Go To SA3: A5 SA Procedure In Service Group 8.
NO
Do All Relays Fail ?
YES
NO
Check Signatures.
U9
Pin 2 056A–A1F3
Pin 7 P08A–4423
Pin 10 P898–4F31
Pin 15 71FF–H565
Your Signature(s)
Are These Signatures Correct ?
NO
Replace U9.
YES
Check Signatures.
U12
Pin 3 0000–P3U9
Pin 6 0000–P3U9
Pin 11 0000–P3U9
Pin 14 0000–P3U9
Your Signature(s)
Are These Signatures Correct ?
NO
Replace U12.
YES
Double Check Address Select Switches.
004
Clock: TP3

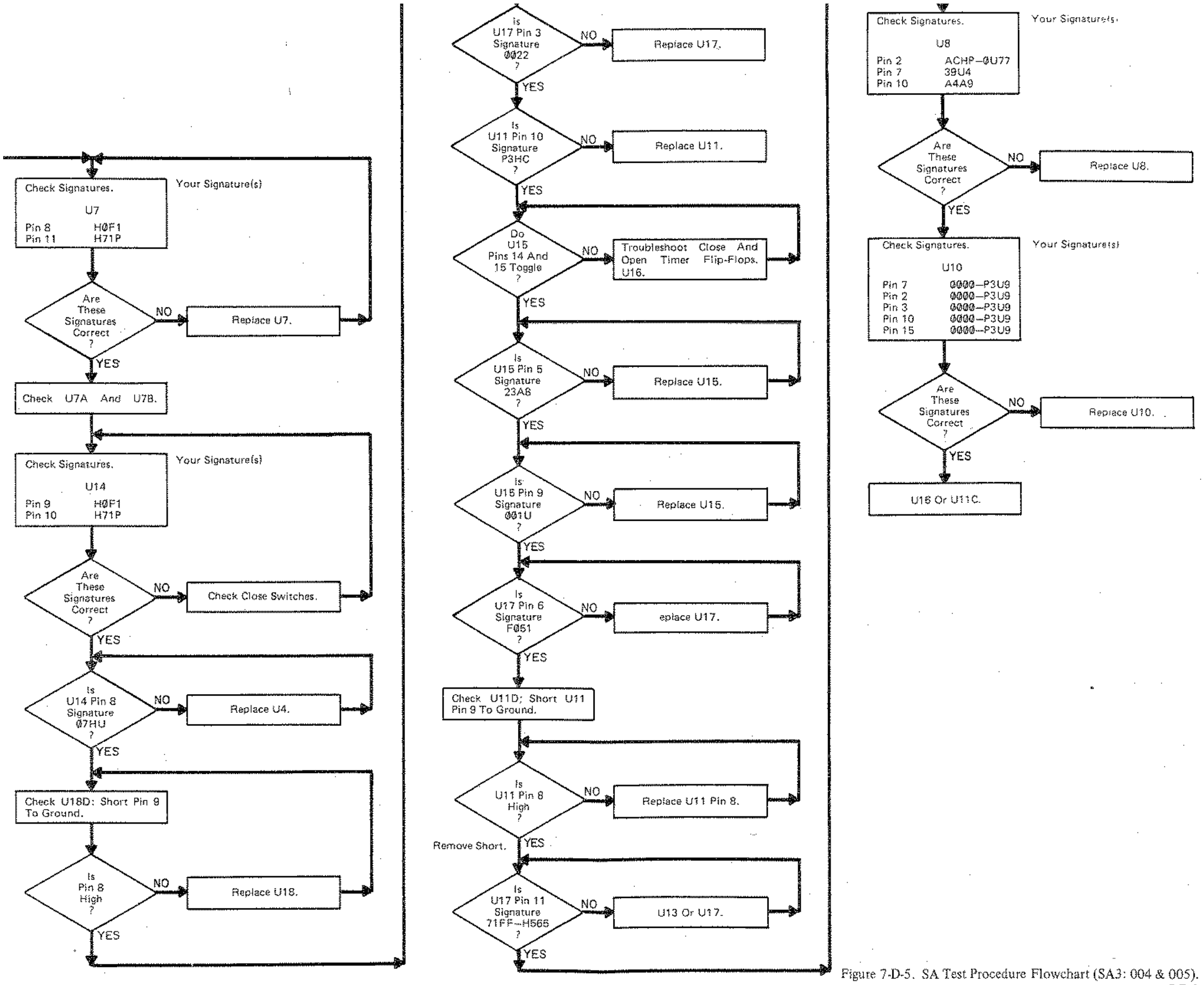


Figure 7-D-5. SA Test Procedure Flowchart (SA3: 004 & 005).

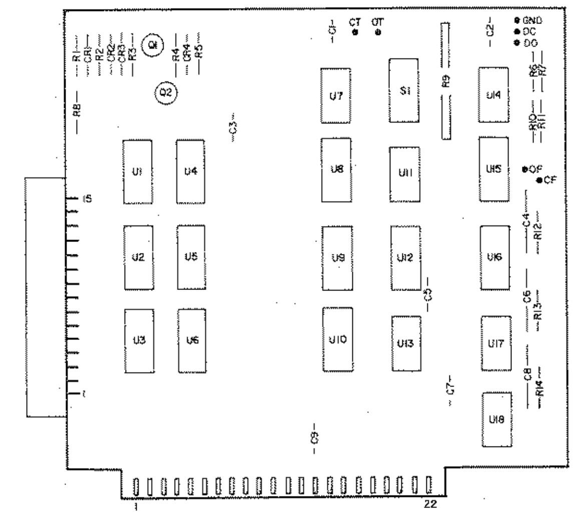


Figure 7-D-6. A40 Component Locator.

A40

U1

Pin	Signature
1–6	0000*–P3U9
11–16	P3U9*–0000

U2

Pin	Signature
1–7	0000*–P3U9
10–16	P3U9*–0000

U3

Pin	Signature
1–8	0000*–P3U9
10–16	P3U9*–0000

U4

Pin	Signature
1–2	0000–P3U9
4–7	**0000*–P3U9**
13,14	0000*–P3U9

U5

Pin	Signature
1–3	0000–P3U9
4–7	**0000*–P3U9**
9–14	0000*–P3U9

U6

Pin	Signature
1–3	0000-P3U9
4–7	**0000*–P3U9**
9–12	**0000*–P3U9**
13,14	0000–P3U9

U7

Pin	Signature
8	**H0F1**
9	P98U
10	HAC7
11	**H71P**
12	FH8U
13	U978

U8

Pin	Signature
2	**ACHP–0U77**
3	PF8P–4827
4	HFPA
5	0158
6	HA0H
7	**39U4**
9	07HU
10	A4A9
11	**4750**
12	5296

U9

Pin	Signature
1	P3HC
2	**056A–A1F3**
3	423A–P693
4	14C3
5	AHC5
6	A7HA–0373
7	**P08A–4423**
9	07HU
10	**P898–4F31**
11	AUF8–0C61
12	CP78
13	2469
14	9235–369F
15	**71FF–H565**

U10

Pin	Signature
2,3	0000–P3U9
4	ACHP–0U77
5	9H5H–39U4
6	0000–P3U9
7	0000–P3U9
10	0000–P3U9
11	0000–P3U9
12	A4A9
13	U413–50CA
14	0000–P3U9
15	0000–P3U9

U11

Pin	Signature
10	**P3HC**
11	0022

U12

Pin	Signature
2	0000–P3U9
3	0000–P3U9
4	A1F3–056A
5	P08A–4423
6	0000–P3U9
7	0000–P3U9
10	0000–P3U9
11	0000–P3U9
12	P898–4F31
13	71FF–H565
14	0000–P3U9
15	0000–P3U9

U13

Pin	Signature
2	001U
12	23A8

U14

Pin	Signature
8	**07HU**
9	**H0F1**
10	**H71P**

U15

Pin	Signature
1	07HU
5	**23A8**
6	F051
7	P3P6
9	**001U**
13	0022

U17

Pin	Signature
3,4	**0022**
6	**F051**
9	U413–50
10	P898–4F
11	**71FF–H5**

U18

Pin	Signature
9	0022
14	P3HC

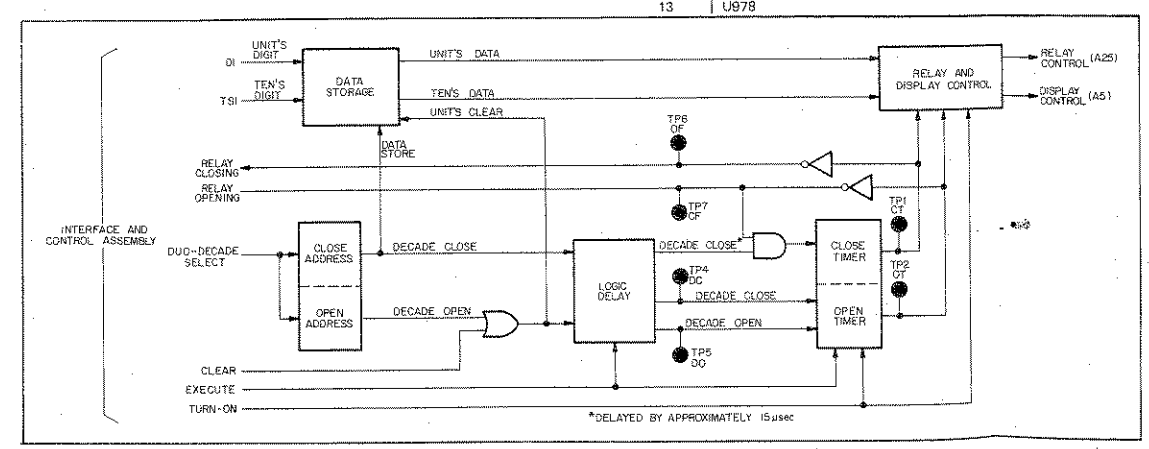


Figure 7-D-7. A40 Block Diagram.

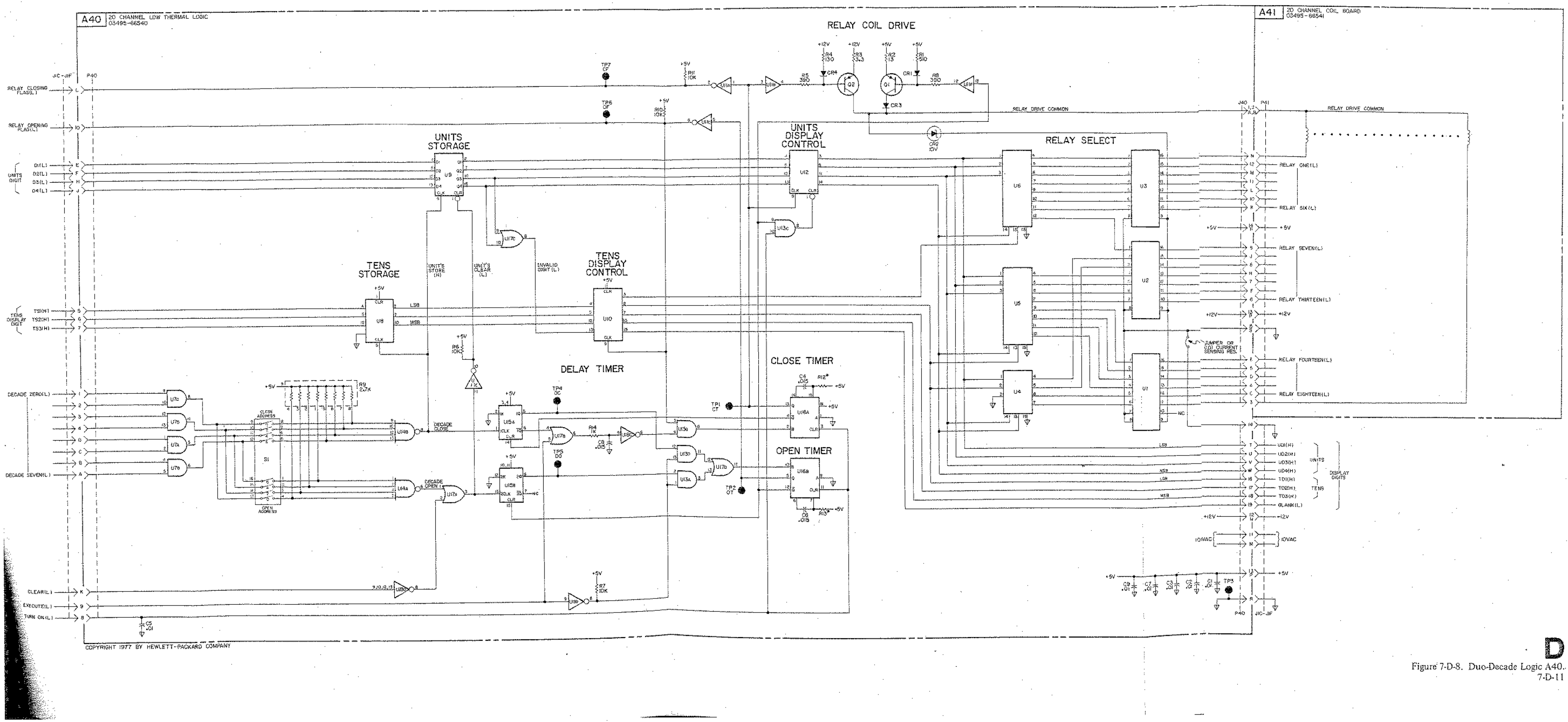
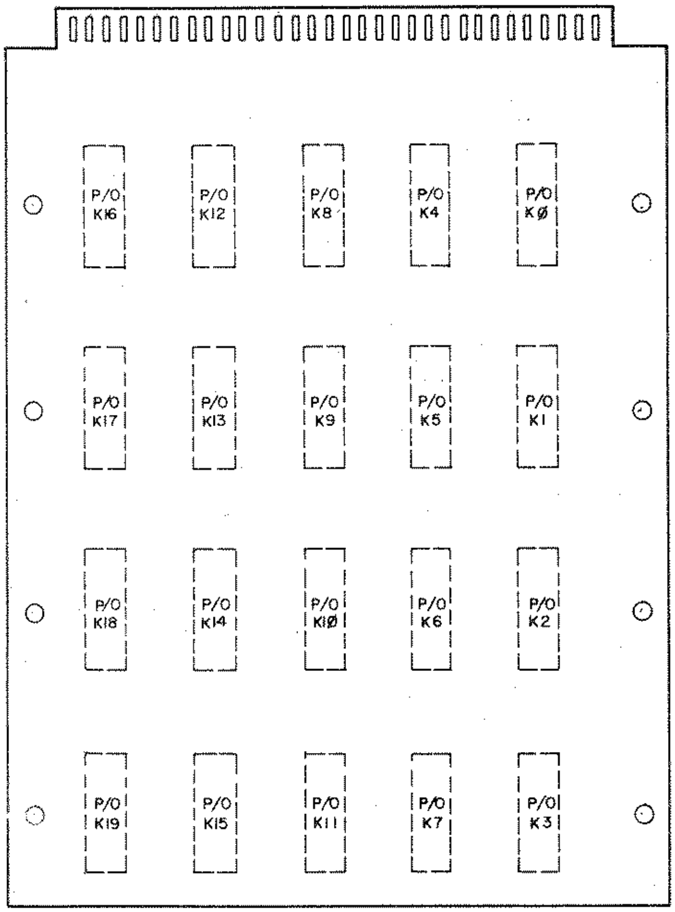


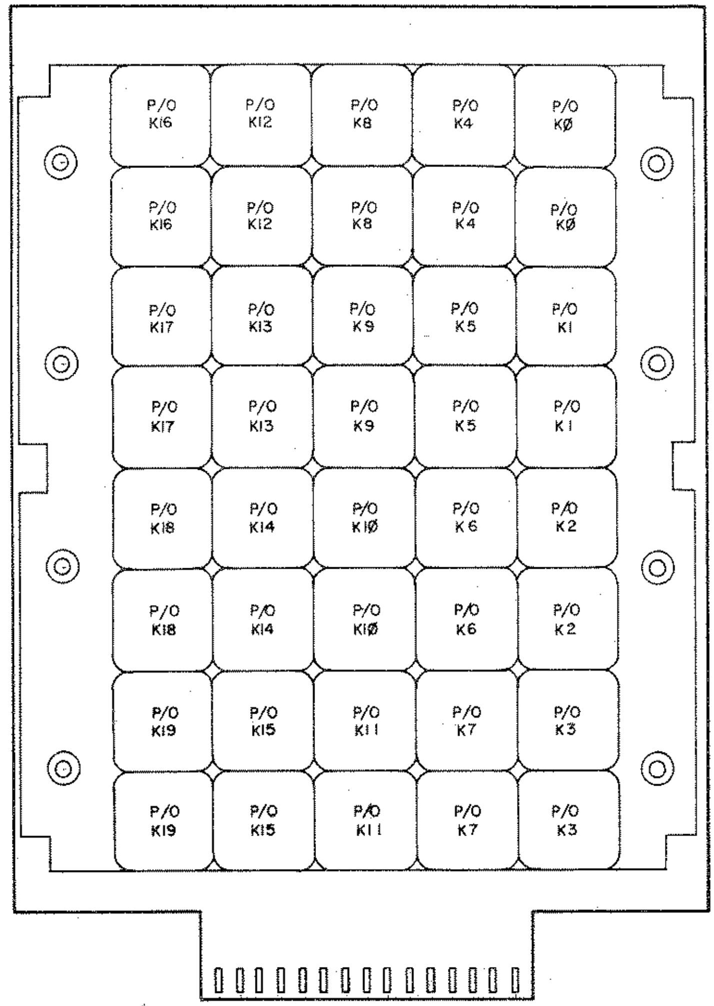
Figure 7-D-8. Duo-Decade Logic A40.
7-D-11

Table 7-D-2. Replaceable Parts.

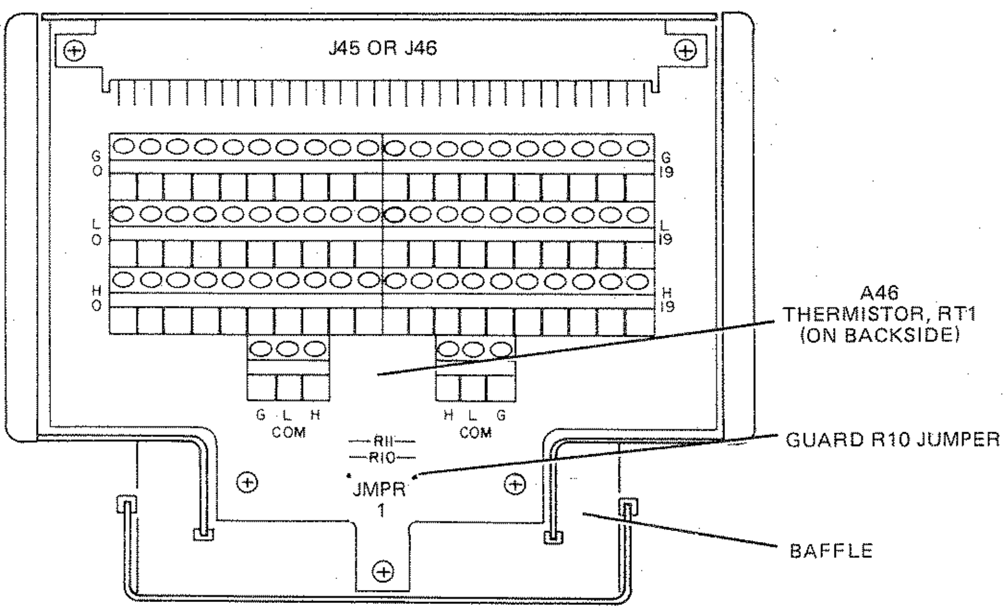
REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
			LOW THERMAL CHANNELS (OPTIONS 004 AND 005)		
A5	03495-66505	1	PC ASSY–DSPLY 2	28480	03495-66505
A5DS1, 2	1990-0490	1	DISPLAY–NUMERIC	28480	1990-0490
A5R1–14	0683-7515	14	RES–FXD 750 Ω .05 .25W	01607	CB7515
A5U1, 2	1820-1233	2	TTL DCDR	28480	1820-1233
			MISCELLANEOUS PARTS		
	1200-0474	2	14 PIN SOCKET IC	04610	C931402
	1251-2034	1	CONN–PC 20(2X10)	04507	252-10-30-300
A25	03495-00101	1	HOUSING OUTER	28480	03495-00101
A41	03495-66541	1	COIL BOARD	28480	03495-66541
A42	03495-66542	1	REED BOARD	28480	03495-66542
P/O K0–K19	03495-81901		REEDS	28480	03495-81901
A45	03495-64114	1	TERM ASSY	28480	03495-64114
A46	03495-64115	1	TERM ASSY TC OPTION 005 ONLY (REPLACES A45)	28480	03495-64115
A46RT1	0837-0148	1	THERMISTOR	28480	0837-0148



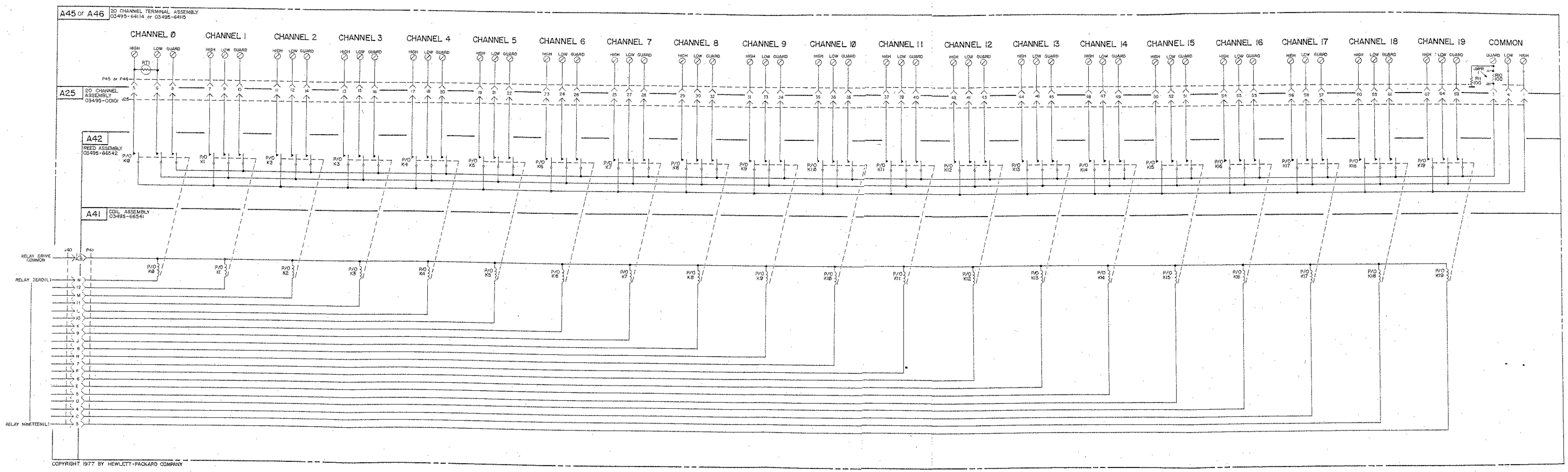
A42
-hp- Part No. 03495-66542
(REEDS ON OPPOSITE SIDE)



A41
-hp- Part No. 03495-66541



A45 or A46
-hp- Part No. 03495-64114
or
-hp- Part No. 03495-64115



D

Figure 7-D-9. Duo-Decade Channels A25, A41, A42, A45, A46.

SERVICE GROUP E
FAST CONTROLLER
OPTION 100 ACCESSORY 44413A

Service Group E contains theory and service information on the microprocessor controlled fast controller for the 3495A Scanner. Signature analysis information is also included.

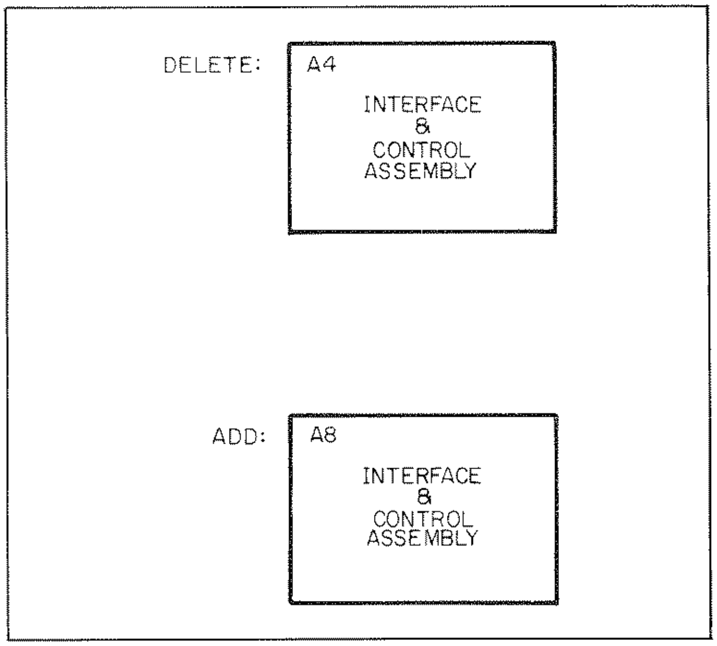


Figure 7-E-1. Service Group E.

Service information on the following assembly is in this service group.

A8 Fast Controller Assembly

Information on the 3495A signature analysis tests is included in this service group.

7-E-1. INTRODUCTION.

7-E-2. The fast controller option is a microprocessor controlled replacement for the A4 interface and control assembly. The A8 assembly is available in place of A4 in Option 100 and as a field installable addition in accessory 44413A.

7-E-3. The fast controller assembly uses an -hp- single chip, N-channel, 8-bit *nano-processor* and program ROM. Jumpers 1 and 2 select power supply voltages for selection of EROM (2708 type) or mask-programmed ROM. A 1 MHz crystal-controlled clock is the clock source for the fast controller.

7-E-4. One factory selected component (R29) is on the A8 interface and control assembly. This resistor is used in the rectification circuitry for supplying a negative back-gate dc bias to the nanoprocessor. The back-gate bias is printed on the U12 nanoprocessor and R29 selected at the factory to supply this bias. A schematic table lists possible values of R29 and the nanoprocessor back-gate voltage delivered by each R29 value. Replacement of your U12 would require replacement of R29.

7-E-5. The features of the A8 fast controller include an expanded instrument instruction set, software and hardware incrementation of channels, and signature analysis test capability throughout the controller and logic assemblies.

7-E-6. The initial increment behavior and SA test routine are selected by switches 6 and 7 respectively on dip switch S1. Closing switch 6 initializes the 3495A in the IØ mode; with the external increment capability disabled, closing switch 7 initiates the SA test routine upon turn-on.

7-E-7. Information in this service group is presented as follows:

a. A8 Fast Controller: Theory of Operation
b. Signature Analysis Tests
c. Service Material

7-E-8. Refer to the A8 block diagram in Figure 7-E-2.

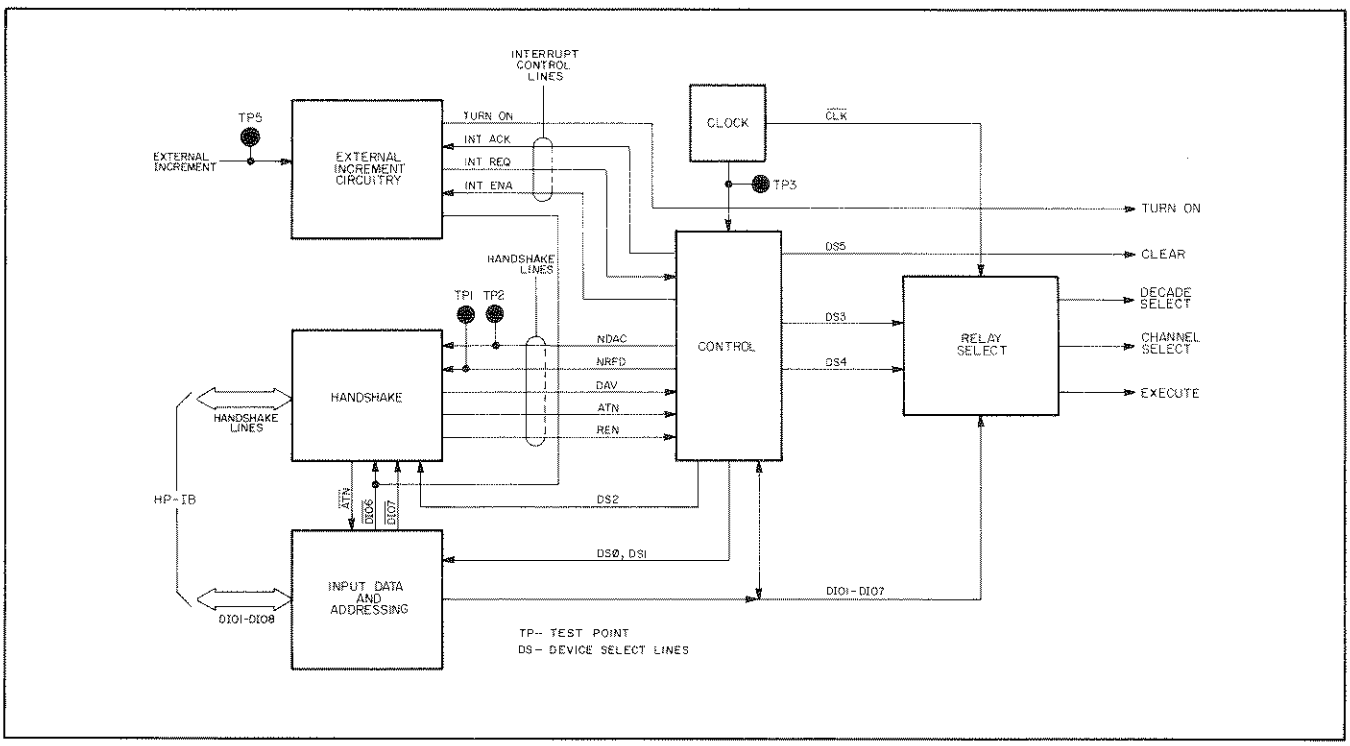


Figure 7-E-2. A8 Block Diagram.

A8 THEORY OF OPERATION

7-E-9. HANDSHAKE BLOCK.

7-E-10. The HP–IB handshake sequence is illustrated in Section III, General HP–IB Programming. Nanoprocessor direct control lines DC0 through DC2 control this sequence when receiving data over the HP–IB.

7-E-11. INPUT DATA AND ADDRESSING BLOCK.

7-E-12. The device select signal DS0 and DS1 are used to gate the selected instrument listen address/increment behavior and input data to the data bus. This information is used for initializing the interrupt circuitry (external increment) and implementing 3495A commands or instructions.

7-E-13. EXTERNAL INCREMENT CIRCUITRY.

7-E-14. The external increment circuitry is enabled (INT ENA high) upon instrument turn-on with dip switch S6 open or upon execution of an "I1" instruction. Once enabled, each high-to-low transition at the external increment input jack causes the 3495A to increment/decrement one channel. The increment behavior and block bounderies are programmable and are discussed in Section III, General HP–IB Programming.

7-E-15. Debounce capacitor C5 can be connected to the external increment input line by installing a jumper. This capacitor should be used for test purposes only (manual switching, etc.) and should be removed for burst measurement applications when high speed operations are required.

7-E-16. CONTROL BLOCK.

7-E-17. Main Control Program.

7-E-18. Refer to the flowchart of the main control and external increment programs. These are shown in Figure 7-E-3.

7-E-19. The control block consists of the U12 nanoprocessor, U10 ROM, U15 decoder, and associated circuitry. Upon instrument turn-on, a start-up vector initializes the NP to address ØØØ. The main control program then clears the atl line (scanner unlistens) to the nanoprocessor and initializes all other lines except handshake lines.

7-E-20. The nanoprocessor enters the handshake sequence. DS1 latches data onto the data bus if DAV is low, and the 3495A is listening or the HP–IB is in the command mode. The ATN signal from the data bus is then checked to distinguish commands from instructions.

7-E-21. If the data received was a command (HP–IB in the command mode), the nanoprocessor checks it for a device clear or selected device clear and a+1. These commands result in reinitializing the handshake lines and the handshake sequence. Other commands are executed accordingly.

7-E-22. If the data received was an instruction (HP–IB in the data mode), the nanoprocessor decodes it and executes it immediately or on a subsequent command mode trigger.

7-E-23. The nanoprocesssor then reinitializes the handshake sequence and the routine repeats.

7-E-24. EXTERNAL INCREMENT ROUTINE.

7-E-25. The external increment signal will implement a vectored interrupt if the external

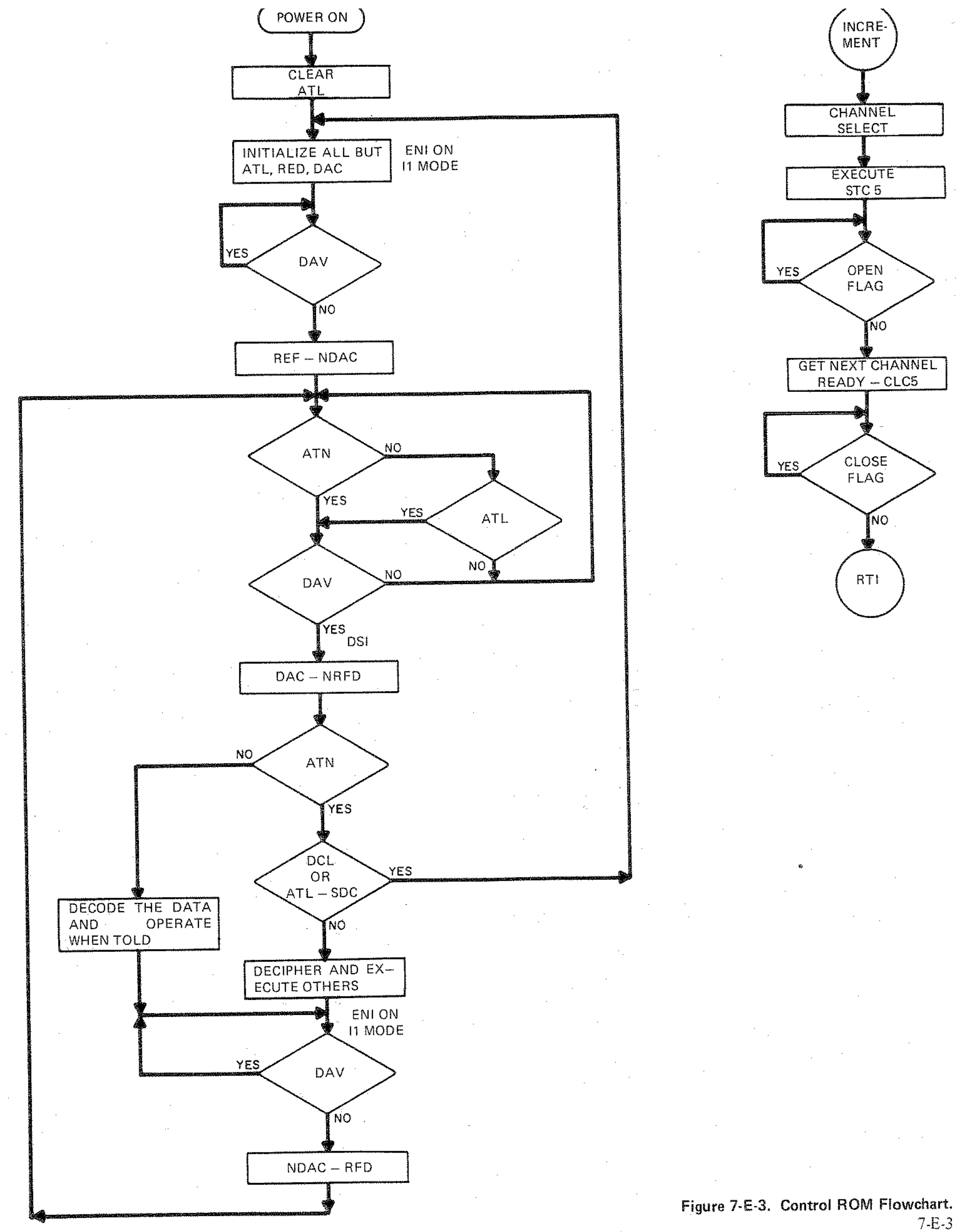


Figure 7-E-3. Control ROM Flowchart.

increment circuitry is enabled and the nanoprocessor is not currently in an interrupt phase.

7-E-26. The increment routine automatically determines the first incremental channel number dependent on the present, first, and last channel values and sends the data to the logic assembly. The clear signal is then initialized and the open flag checked (A40) assembly in the open timer interval).

7-E-27. When the relays have opened the relay opening flag goes high and the nanoprocessor determines the next incremental channel.

7-E-28. The relay closing flag goes high at the end of the close timer interval signifying that the selected relay has closed. The nanoprocessor then returns to the main control program.

7-E-29. The external increment routine allows the 3495A to change channels without performing the HP–IB handshake sequence. The power-up external increment capability of the fast controller eliminates the need to program this capability. The scanner need not be listening.

7-E-30. SIGNATURE ANALYSIS TESTS.

7-E-31. Four signature analysis routines are stored on the A8 read only memory. These four routines are used to generate recurring data throughout the 3495A control, logic, and display assemblies. With the use of an -hp- Model 5004A Signature Analyzer, this data can be interpreted as characteristic signatures and compared to factory values. To implement the SA tests, close switch 7 on the listen address dip switch. Upon turn-on the nanoprocessor will initialize the first SA test routine.

7-E-31. SAØ, ROM Verification Test.

7-E-32. This test checks the ROM and nanoprocessor if the power supply signature is incorrect although the test set-up is correct. Test point 3(_⌠¯) provides the clock. The positive and negative edges at test point 4 provide the start and stop signals respectively for this test. Open the jumpers at the ROM output lines (Pins 9–11, 13–17). Using an -hp- Model 5004A Signature Analyzer, check the signatures at the pins listed in the SAØ troubleshooting procedure diagram.

7-E-33. SA1, HP–IB Data Bus Tests.

7-E-34. The second test checks the circuitry which affects the data bus. The positive and negative edges at test poins 1 and 2 provide the start and stop signals respectively. The ROM jumpers are in for all remaining tests. This test requires three configurations to implement its three parts. For each part,

a. configure the circuit;

b. Turn on the 3495A;

c. Proceed to check the signatures as directed on the SA troubleshooting procedure diagram.

CONFIGURATION 1. The first configuration is as follows:

a. Start (_⌠¯) and stop (¯⌡_) signals at *Test Point 1*.

b. All dip switches *open* except S7.

c. All HP–IB data lines *open*.

CONFIGURATION 2. The second configuration is as follows:

a. Start (_⌐) and stop (¬_) signals at *test point 2.*

b. All dip switches *open* except S7.

c. All HP–IB data lines shorted to ground.

CONFIGURATION 3. The third configuration is as follows:

a. Start (_⌐) and stop (¬_) signals at *test point 2.*

b. All dip switches *closed.*

c. All HP–IB data lines open.

7-E-35. The scanner should increment through all possible channels (ØØ through 79) at approximately 1/2 second intervals. Thus, all decade and duo-decade address selections can be determined and all displays checked.

7-E-36. The SA1 routine also provides known changing data throughout the logic and display assemblies for use in conventional troubleshooting procedures.

7-E-37. SA2, U13 TEST.

7-E-38. The third test checks the U13C inverter. The positive and negative edges at test point 2 provide the start and stop signals, respectively. The configuration need not be changed.

7-E-39. SA3, INSTRUMENT TEST.

7-E-40. The fourth test checks the remaining logic and display assemblies. The start (_⌐) and stop (¬_) signals are obtained at test point 1. The signatures given in the signature tables apply for options addressed as follows:

Option Tested		Others	
Close	Open (Clear)	Close	Open (Clear)
0–7	None	None	None

7-E-41. The SA troubleshooting procedure begins in Figure 7-E-4. The signatures are listed in tables located on the schematic pages in the service groups where the assemblies occur, and incorporated into the procedure diagram in that service group. Spaces are provided next to the diagram signature blocks to pencil in your test values for quick reference. The SA summary page preceding the procedure diagram illustrates the test sequence.

7-E-42. SERVICE MATERIAL.

7-E-43. The following pages contain service material for the fast controller assembly. Included is a signature analysis summary page, an SA test procedure flowchart (Figure 7-E-4), a replaceable parts list (Table 7-E-1), and A8 component locator (Figure 7-E-5), an A8 block diagram (Figure 7-E-6), and a schematic (Figure 7-E-7).

SA TEST PROCEDURES SUMMARY

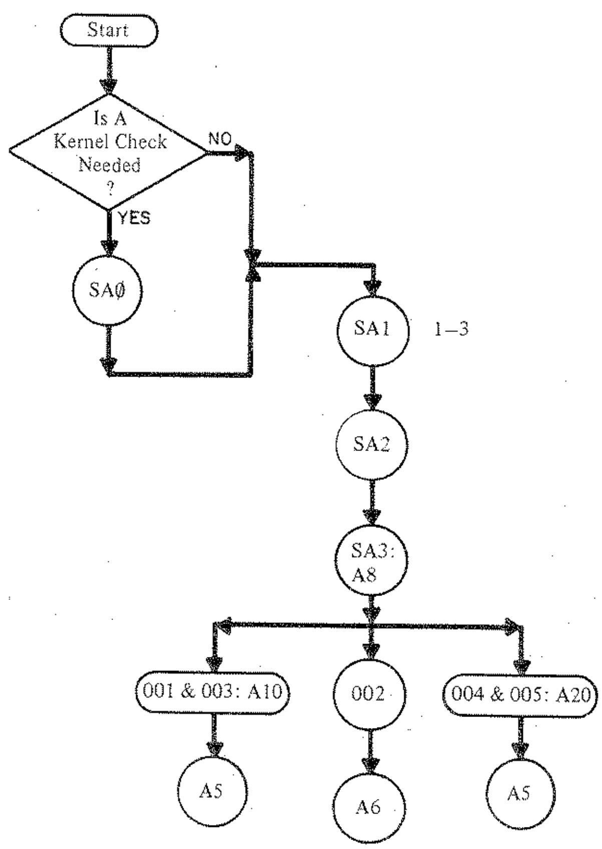
1. All SA tests performed with 5004A *hold* and *self-test* functions OFF (out).
2. Hyphenated (–) signatures have alternating values.
3. * indicates predominant signature.
4. Signatures included in the SA test procedures are in **bold** type.
5. RED signatures comprise the abbreviated SA tests.

SA Test Set–Ups

Test	S1–S6	J2–J8	Clock	Start	Stop	DIO1–8 To Ground
SAØ	Closed	Open	TP3	TP4	TP4	Open
SA1						
Configuration 1	Closed	Closed	TP3	TP1	TP1	Open
Configuration 2	Closed	Closed	TP3	TP2	TP2	Shorted
Configuration 3	Open	Closed	TP3	TP2	TP2	Open
SA2	Open	Closed	TP3	TP2	TP2	Open
SA3[1]	Open	Closed	TP3	TP1	TP1	Open

[1] Clear addresses of 2 – 7. Close address of 1 for Options 001 – 003 and 0 for Options 004 and 005.

SA Test Procedure Flowchart



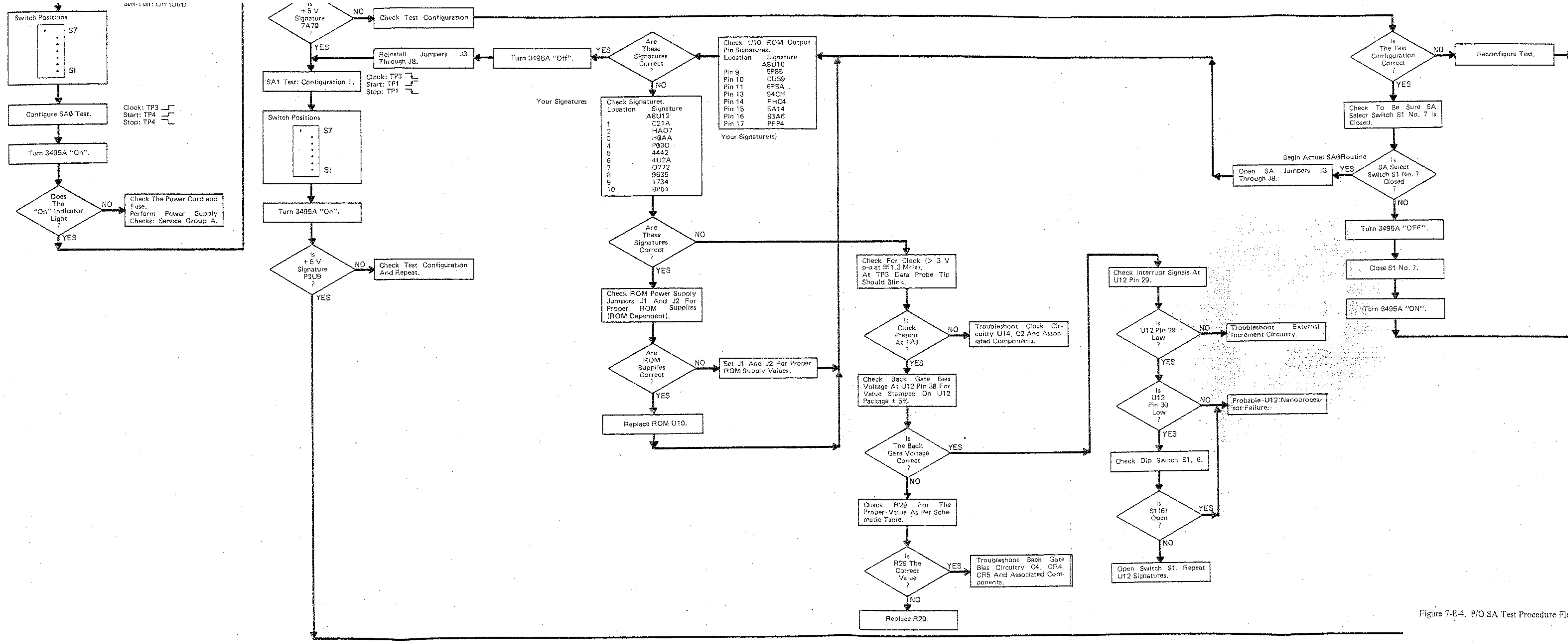
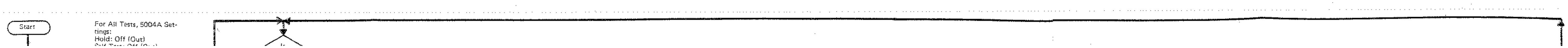


Figure 7-E-4. P/O SA Test Procedure Flowchart (SA0 thru S
7-



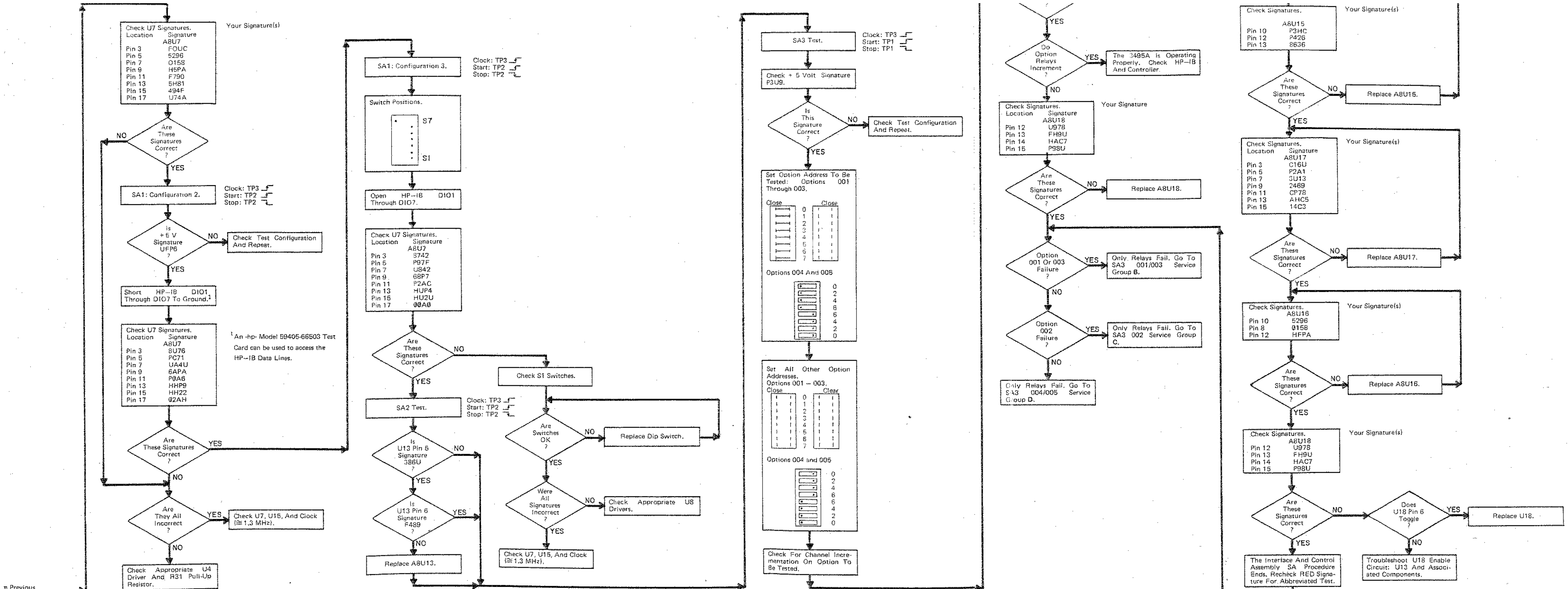
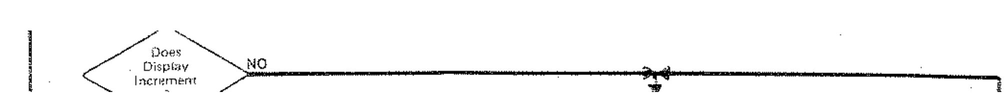


Figure 7-E-4. P/O SA Test Procedure Flowchart (SA0 thru SA3: A8).



REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
			FAST CONTROLLER – OPTION 100		
A8	03495-66508	1	SCANNER CONTROL	28480	03495-66508
A8C1	0180-0228	1	CAP–FXD 22 µF 15 V	04200	150D226X9015B2
A8C2	0160-3847	1	CAP–FXD .01µF 50 VDC	28480	0160-3847
A8C3	0160-0362	1	CAP–FXD 510 pF 300 V	28480	0160-0362
A8C4	0180-0098	1	CAP–FXD 100µF 20 V	04200	150D107X002052
A8C5–7,9–12, 14, 15	0180-0197	9	CAP–FXD 2.2 µF 20 V	04200	150D225X9020A2
A8C8	0180-1746	1	CAP–FXD 15 µF ± 10% 20 VDC TA	04200	150D156X9020B2
A8C13	0140-0198	1	CAP–FXD 200 pF 300 V	04522	DM15F201J0300WV1CR
A8CR1, 2	1901-0040	3	DIO–SI .05 A 30 V	28480	1901-0040
A8CR3	1902-3030	1	DIO–BKDN 3.01 V	02037	SZ10939-32
A8CR4	1902-0041	1	DIODE–ZNR 5.11 V 5%	02763	CD 35622
A8CR5	1901-0040		DIO–SI .05 A 30 V	28480	1901-0040
A8J5	1250-0083	1	CONN RF BNC FEM SGL	03216	28JR-130-1
A8J8	1251-3283	1	CONN 24 PIN HP–IB	28480	1251-3283
A8R1	0757-0429	6	RES–FXD 1820 Ω .01 .125W	03292	C4-1/8-T0-1821-F
A8R2	0757-0281	4	RES–FXD 2740 Ω .01 .125 W	03292	C4-1/8-T0-2741-F
A8R3	0757-0429		RES–FXD 1820 Ω .01 .125 W	03292	C4-1/8-T0-1821-F
A8R4	0757-0281		RES–FXD 2740 Ω .01 .125 W	03292	C4-1/8-T0-2741-F
A8R5	0757-0429		RES–FXD 1820 Ω .01 .125 W	03292	C4-1/8-T0-1821-F
A8R6	0757-0281		RES–FXD 2740 Ω .01 .125 W	03292	C4-1/8-T0-2741-F
A8R7	0757-0429		RES–FXD 1820 Ω .01 .125 W	03292	C4-1/8-T0-1821-F
A8R8	0757-0281		RES–FXD 2740 Ω .01 .125 W	03292	C4-1/8-T0-2741-F
A8R9	0757-0428	4	RES–FXD 1620 Ω .01 .125 W	03292	C4-1/8-T0-1621-F
A8R10	0757-0431	4	RES–FXD 2430 Ω .01 .125 W	03292	C4-1/8-T0-2431-F
A8R11	0757-0428		RES–FXD 1620 Ω .01 .125 W	03292	C4-1/8-T0-1621-F
A8R12	0757-0431		RES–FXD 2430 Ω .01 .125 W	03292	C4-1/8-T0-2431-F
A8R13	0757-0428		RES–FXD 1620 Ω .01 .125 W	03292	C4-1/8-T0-1621-F
A8R14	0757-0431		RES–FXD 2430 Ω .01 .125 W	03292	C4-1/8-T0-2431-F
A8R15	0757-0428		RES–FXD 1620 Ω .01 .125 W	03292	C4-1/8-T0-1621-F
A8R16	0757-0431		RES–FXD 2430 Ω .01 .125 W	03292	C4-1/8-T0-2431-F
A8R17	0757-0283	4	RES–FXD 2000 Ω .01 .125 W	03292	C4-1/8-T0-2001-F
A8R18	0757-0465	1	RES–FXD 100 kΩ .01 .125 W	03292	C4-1/8-T0-1003-F
A8R19	0757-0280	4	RES–FXD 1000 Ω .01 .125 W	03292	C4-1/8-T0-1001-F
A8R20, 21	0757-0283		RES–FXD 2000 Ω .01 .125 W	03292	C4-1/8-T0-2001-F
A8R22	0757-0280		RES–FXD 1000 Ω .01 .125 W	03292	C4-1/8-T0-1001-F
A8R23	0757-0429		RES–FXD 1820 Ω .01 .125 W	03292	C4-1/8-T0-1821-F
A8R24	0757-0280		RES–FXD 1000 Ω .01 .125 W	03292	C4-1/8-T0-1001-F
A8R25	0757-0429		RES–FXD 1820 Ω .01 .125 W	03292	C4-1/8-T0-1821-F
A8R26	0757-0401	1	RES–FXD 100 Ω .01 .125 W	03292	C4-1/8-T0-101-F
A8R27	0757-0407	1	RES–FXD 200 Ω .01 .125 W	03292	C4-1/8-T0-201-F
A8R28	0757-0280		RES–FXD 1000 Ω .01 .125 W	03292	C4-1/8-T0-1001-F
A8R29			PAD VALUE (RES–FXD)		
	0757-0440		–6: 20 K	03292	C4-1/8-T0-7501-F
	0698-3518		–4.5: 7.32 K	03292	C4-1/8-T0-7321-F
	0698-3558		–4: 4.02 K	03292	C4-1/8-T0-4021-F
	0698-0084		–3.5: 2.15 K	03292	C4-1/8-T0-2151-F
	0698-3225		–3: 1.43 K	03292	C4-1/8-T0-1431-F
	0757-0280		–2.5: 1 K	03292	C4-1/8-T0-1001-F
	0698-4459		–2: 649 K	03292	C4-1/8-T0-634R-F
		1	RES–FXD 200 Ω .01 .125 W	03292	C4-1/8-T0-201-F
			RES–FXD 1000 Ω .01 .125 W	03292	C4-1/8-T0-1001-F
A8R30	0757-0283		RES–FXD 2000 Ω .01 .125 W	03292	C4-1/8-T0-2001-F
A8R31	1810-0269	1	RES NETWORK 9-PIN SIP	28480	1810-0269
A8R32	1810-0263	1	RES NETWORK 10-PIN SIP	28480	1810-0263
A8S1	3101-1973	1	SW ASSY–SL	02484	11P-1028
A8U1	1820-1209	2	IC BFR TTL	01698	SN74LS38N
A8U2	1820-1144	1	IC–GATE TTL	02037	MC14516CP
A8U3–5	1820-1416	3	IC–SCHMITT–TRIG TTL	01698	SN74LS14N
A8U6	1820-1112	2	IC FF TTL LS D–TYPE	01698	SN74LS74N
A8U7	1820-1759	1	IC–BFR TTL LS	03406	DM81LS97N
A8U8	1820-1200	2	IC INV TTL	02237	9LS05PC
A8U9	1820-1112		IC FF TTL LS D–TYPE	01698	SN74LS74N
A8U11	1820-1209		IC BFR TTL	01698	SN74LS38N
A8U12	1820-1691	1	IC–MICPROC MOS	28480	1820-1691
A8U13, 14	1820-1199	3	IC INV TTL	01698	SN74LS04N
A8U15	1820-1216	1	IC–DCDR TTL LS	01698	SN74LS138N
A8U16	1820-1199		IC INV TTL	01698	SN74LS04N
A8U17	1820-1873	1	IC–BFR TTL LS	03406	DM81LS98N
A8U18	1820-1240	1	IC DCDR TTL	01698	SN74S138N
A8Y1	0410-1001	1	CRYSTAL–QUARTZ	28480	0410-1001

Table 7-E-1. Replaceable Parts.

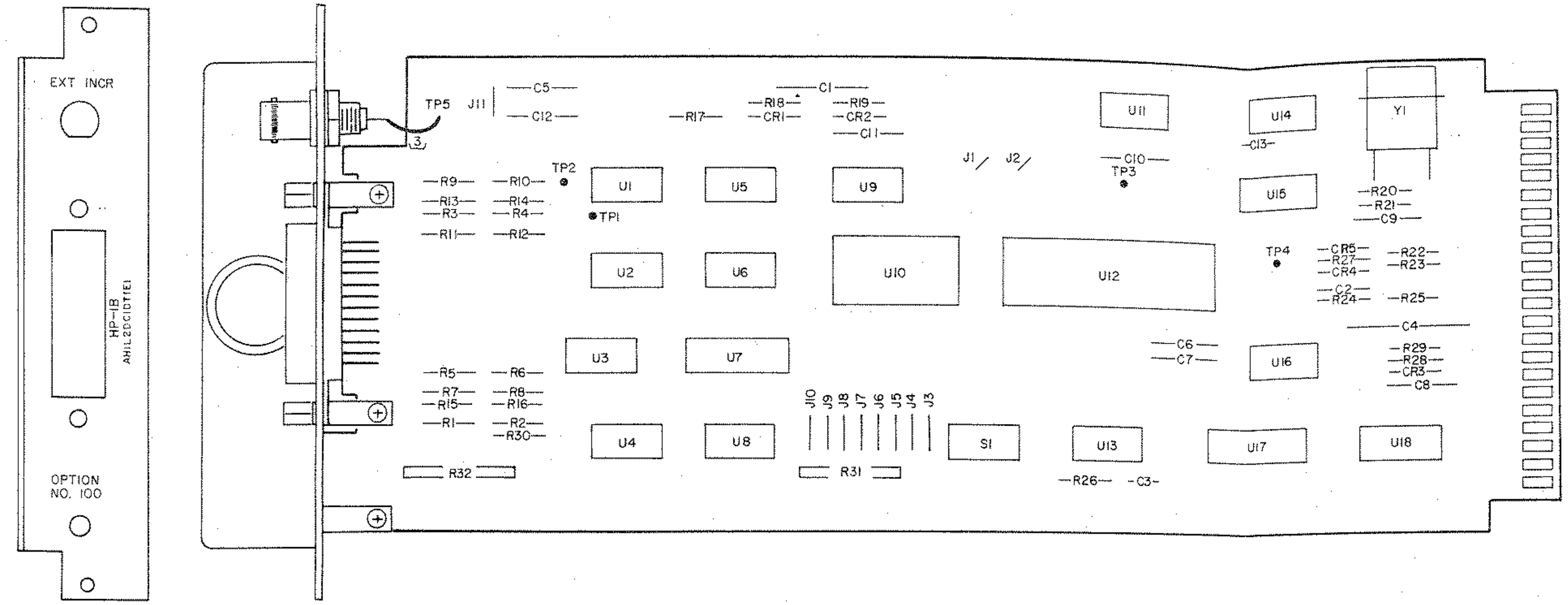


Figure 7-E-5. A8 Component Locator.

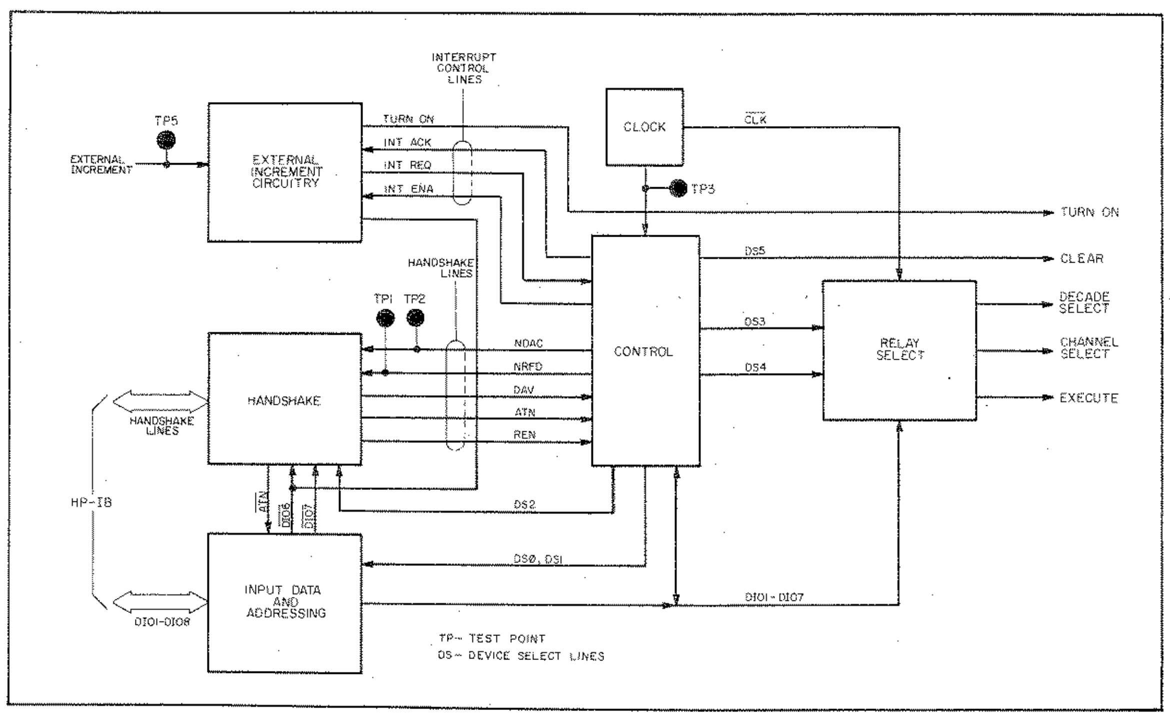


Figure 7-E-6. A8 Block Diagram.

SAØ ROM VERIFICATION TEST
+5 V 7A7Ø

A8U10

Pin	Signature
9	5P85
10	CU59
11	6P5A
13	94CH
15	FHC4
16	5A14
17	83A6
18	PFP4

A8U12

Pin	Signature
1	C21A
2	HAØ7
3	HØAA
4	PØ3Ø
5	4442
6	4U2A
7	Ø772
8	9635
9	1734
10	8P54

SA1 HP–IB DATA BUS TEST

CONFIGURATION 1
+5 V P3U9

A8U7

Pin	Signature
3	FØUC
5	5296
7	Ø158
9	H5PA
11	F79Ø
13	5H81
15	494F
17	U74A

CONFIGURATION 2
+5 V UFP6

A8U7

Pin	Signature
3	8U76
5	PC71
7	UA4U
9	6APA
11	PØA6
13	HHP9
15	HH22
17	Ø2AH

CONFIGURATION 3
+5 V UFP6

A8U7

Pin	Signature
3	8742
5	P97F
7	U842
9	68P7
11	P2AC
13	HUP4
15	HU2U
17	ØØAØ

SA2 U13 TEST

+5 V 386U

A8U13

Pin	Signature
5	386U
6	FH89

SA3: A8 INSTRUMENT TEST

+5 V P3U9

A8U1

Pin	Signature
5	ØU14
8	PFPH
10	ØU14
11	4P4F

A8U2

Pin	Signature
9	ØU14
10	
12	PFPH
13	ØU14

A8U6

Pin	Signature
2	4P4F
3	8636
5	ØU14
6	PFPH
11	8636
12	U74A

A8U7

Pin	Signature
3	FØUC
5	5296
7	Ø158
9	HFPA
11	F79Ø
13	5H81
15	4P4F
17	U74A

A8U11

Pin	Signature
8	U74A
11	4P4F

A8U12

Pin	Signature
1	ØU1P
2	Ø16Ø
3	1C74
4	75U2
5	P3Ø7
6	ØØUP
12	81F6
13	81P9
14	P3HC
15	8636
18	U74A
19	4P4F
20	5H81
21	F79Ø
22	HFPA
23	Ø158
24	5296
25	FØUC
26	13A1
34	ØU14

A8U13

Pin	Signature
10	UØ58
11	13A1

A8U15

Pin	Signature
1	8636
2	P3HC
3	81P9
7	6232
10	P3HC
12	P426
13	8636

A8U16

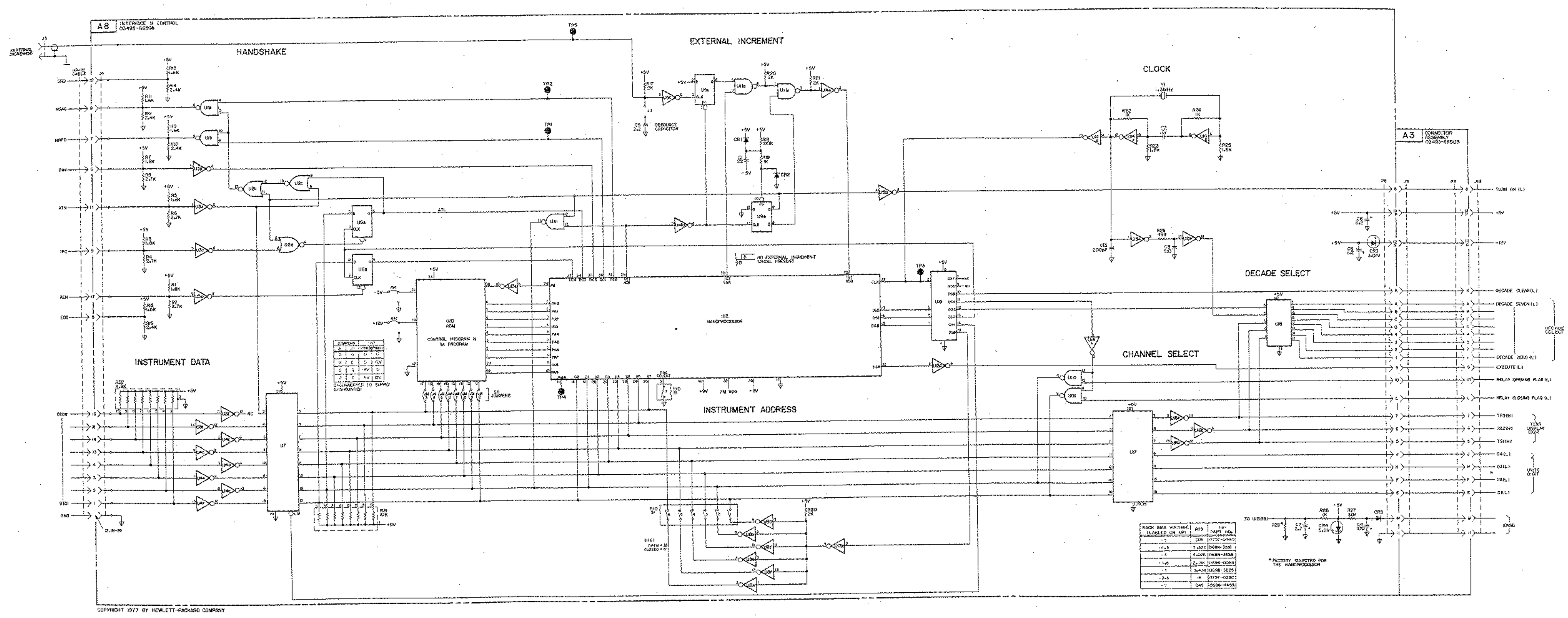
Pin	Signature
8	Ø158
9	P2A1
10	5296
11	C16U
12	HFPA
13	3U13

A8U17

Pin	Signature
2	5296
3	C16U
4	Ø158
5	P2A1
6	HFPA
7	3U13
8	F79Ø
9	2469
11	CP78
12	5H81
13	AHC5
14	4P4F
15	14C3
16	U74A

A8U18

Pin	Signature
1	HFPA
2	Ø158
3	5296
5	P426
12	U978
13	FH9U
14	HAC7
15	P98U



E

Figure 7-E-7. High Speed Controller, A8.
7-E-11/7-E-12

APPENDIX A

A-1. INTRODUCTION.

A-2. This information is provided as a general summary of 9830A Calculator programming techniques for the Hewlett-Packard Model 3495A Scanner. It serves as a basic programming guide which you can refer to when developing 9830A programs for the 3495A Scanner.

3495A PROGRAMMING GUIDE FOR THE -hp- MODEL 9830A CALCULATOR

A-3. HP–IB COMMAND MODE.

A-4. The methods shown in Table A-1 and explained in this section may be used to put the HP–IB in the Command mode for addressing the calculator to talk and the 3495A to listen, and to clear or trigger the 3495A. Literal commands are used when they are to be constant in the program; computed commands are used when they are to be variable, dependent upon prior INPUT, READ, ENTER, STAT or RBYTE statements, or computations. Table A-2 lists the 3495A commands.

Table A-1. 9830A Command Methods.

LITERAL COMMANDS	10 CMD"*commands*" 10 FORMAT B, "*commands*" 20 OUTPUT (13,10) 256;
COMPUTED COMMANDS	10 FORMAT 3B 20 OUTPUT (13,10) 256, *command*, *command*; 10 OUTPUT (13,*) WBYTE 256, WBYTE *command*, WBYTE *command*;

NOTE

A WRITE statement may be used instead of OUTPUT except to address the calculator to talk. Example 2 will not work with WRITE because it addresses the calculator to talk.

A-5. Literal Commands.

A-6. The CMD statement gives the Command mode, sends the commands, and returns the HP–IB to the Data mode. CR/LF characters are not sent. String variables may be used in the CMD statement if the String Variables ROM is installed in the calculator. The "256" term gives the HP–IB Command mode; it may be omitted if it has previously been executed and the "512" term (under binary format) or CMD has not been executed since then. The last semicolon in the OUTPUT statement suppresses CR/LF, but these two characters are ignored anyway by the 3495A in the Command mode. The "commands" term may appear in the FORMAT or OUTPUT statement. The calculator keys that give the commands within the quote field of either statement are listed in Table A-3.

Table A-2. Commands.

Command	ASCII	DIO7–DIO1	Decimal	Comments
Selected Device Clear (SDC)	EOT	0000100	4	Scanner Must Be Listening With The HP-IB In The Command Mode.
Group Execute Trigger (GET)	BS	0001000	8	
Device Clear (DCL)	DC4	0010100	20	Scanner Must Be Listening
My Listen Address (MLA)	Table 3-1	Table 3-1	Table 3-1	The HP-IB Must Be In The Command Mode To Address The Scanner.
Unlisten Address (UNL)	?	0111111	63	

A-7. Computed Commands.

A-8. See Literal Commands concerning the "256" term. The "command" term must be an expression equal to a decimal number in Table A-2. CR/LF are suppressed by the semicolon at the end of the OUTPUT statement. (In the free-field format—(13,*)—the CR/LF characters are initially suppressed by the semicolon, but they will eventually be issued if more than 72 characters are output (contiguously or not) under the free-field format, or if an END or STOP statement is encountered, or if the STOP key is pressed.)

Table A-3. 9830A Command Keys.

COMMAND	KEY OR KEYS
SDC*	f_6 D
GET*	f_6 H
DCL*	f_6 T
MLA	Key or SHIFT key corresponding to an MLA character in Table 3-1, with the following exception:
"*	f_5 f_6 2
UNL	?

*Terminal I ROM required; calculator must be in TEXT mode. See Terminal I ROM manual for further information.

A-9. HP–IB DATA MODE (Table A-3).

A-10. The methods shown in Table A-4 and explained in this section may be used to put the HP–IB in the Data mode and instruct the 3495A to close and open channels. Literal instructions are used when they are to be constant in the program; computed instructions are used when they are to be variable, dependent upon prior INPUT, READ, ENTER, STAT or RBYTE statements, or computations. CR/LF characters are automatically sent as an "execute" instruction at the end of the OUTPUT statement; these characters may be suppressed by a semicolon at the end of the OUTPUT statement if they are not wanted at this time; but see Computed Commands concerning suppression of CR/LF under a free-field format. See Table A-5 for the list of instructions.

NOTE

A WRITE statement may be used instead of OUTPUT unless the calculator is addressed to talk in the same WRITE or related FORMAT statement. Example 2 will not work with WRITE because it addresses the calculator to talk.

Table A-4. 9830A Instruction Methods.

LITERAL INSTRUCTIONS	10 CMD"","*instructions*" 10 FORMAT B,"*instructions*" 20 OUTPUT (13,10)512 10 OUTPUT (13,*)WBYTE 512, "*instructions*"
COMPUTED INSTRUCTIONS	10 OUTPUT (13,*)WBYTE 512, WBYTE *instruction*, WBYTE *instruction*
COMPUTED CHANNELS	10 FORMAT B,2F3.0 20 OUTPUT (13,10)512, *channel*, *channel*

A-11. Literal Instructions.

A-12. The "instruction" term is a literal string of instructions. The CMD statement may be used to alternately select the HP–IB Command and Data modes any number of times needed, limited only by line length; however, it always leaves the HP–IB in the Data mode. If it is not wanted to send commands, the Command mode may be effectively skipped by using an empty quote field as shown. The "512" term gives the HP–IB Data mode; it may be omitted unless the HP–IB has been left in the Command mode by a previously executed "265" term under the binary format. A –CMD""– statement may be substituted for the "512" term. Instruction "E" is not required at the end of the FORMAT or OUTPUT "instructions" string because CR/LF are automatically sent as the last characters.

Table A-5. Instructions.

INSTRUCTION	ASCII CHARACTER	DECIMAL
Digit	0,1,2,3,4,5,6,7,8,9	48 thru 57
Space	SP	32
Clear	C	67
Execute	Carriage Return (CR), E	13, 69
External Increment Off	I0	73 48
External Increment On	I1	73 49
First Channel	F	70
Last Channel	L	76
Software Increment	S	83
No Operator	NUL, DEL	0, 127
Delimiter	Any other character	1 thru 126*

*With preceding exceptions

A-13. Computed Instructions.

A-14. The WBYTE 512 term may be omitted under the conditions described in Literal Instructions. The "instruc-

tion" term must be an expression equal to a decimal number in Table A-5.

A-15. Computed Channels.

A-16. The "512" term may be omitted under the conditions described in Literal Instructions. The "channel" term must be an expression equal to one channel number 0 to 79. Three characters are sent to the 3495A under an F3.0 format: space-space-digit or space-digit-digit. The first sequence is sent for channel numbers 0 through 9, the second sequence for channels 10 through 79. This method requires 10 msec more time per channel than the previous two methods because of the carriage return and line field characters that are automatically sent.

A-17. A decade of channels may be opened by sending the ten's channel digit under an F2.0 format followed by an "execute" instruction. Digits 0 through 7 clear decades 0 through 7, digit 8 clears decade 0, and digit 9 clears decade 1.

A-18. EXAMPLES.

A-19. Each of the following examples closes channel 36 if the calculator has talk address "U" and the 3495A has listen address ")":

1)
```
10 CMD"?U)","36E"
```

2)
```
10 FORMAT B, "?U)",B,"36"
20 OUTPUT (13,10)256,512
```

3)
```
10 OUTPUT (13,*)WBYTE 256,WBYTE 63,
   WBYTE 85,WBYTE 41, WBYTE 512,
   WBYTE 48+3,WBYTE 48+6
```

NOTE

"85" is decimal number for ASCII "U".

4)
```
10 FORMAT B,"?U)",B,F3.0
20 OUTPUT (13,10)256,512,36
```

5)
```
10 CMD"?U)"
20 FORMAT F3.0
30 OUTPUT (13,20)36
```

6)
```
10 CMD"?U)"
20 FORMAT "3",F2.0
30 OUTPUT (13,20)6
```

7)
```
10 CMD"?U)"
20 FORMAT 2F2.0
30 OUTPUT (13,20)3,6
```

APPENDIX B

B-1. INTRODUCTION.

B-2. This information is provided as a general summary of 9825A calculator programming techniques for the Hewlett-Packard Model 3495A Scanner. It serves as a basic programming guide which you can refer to when developing 9825A programs for the 3495A Scanner.

3495A PROGRAMMING GUIDE FOR THE -hp- MODEL 9825A CALCULATOR

B-3. HP–IB Command Mode.

B-4. Literal commands are sent using the CMD 7 statement as shown in Table B-1. The command statement places the HP–IB in the Command mode, sends the commands, and returns the HP–IB to the Data mode. The select code is required and must correspond to the Select code on the 98034A Interface Card (assumed 7 here). Carriage-Return and Line Feed characters are not sent when the CMD statement is executed. The commands within the quote field of the statement are ASCII characters corresponding to the commands listed in Table B-2. The 9825A statements that produce 3495A commands are listed in Table B-3.

B-5. The 9825A is addressed to talk and the 3495A to listen by the select code parameter in the CMD and WRT statements. Addressing with these statements is shown in Table B-1.

B-6. The 9825A can send special command statements to trigger (GET) or clear (DCL and SDC) the 3495A in the Command mode. The 9825A special command statements are shown in Table B-1.

B-7. HP–IB Data Mode.

B-8. Channels are programmed by instructions sent while the HP–IB is in the Data mode. Instructions can be sent as literal instruction strings, variables, or channel numbers. Literal instructions are used when channel numbers are constant in a program. Computed instructions are used when channel numbers are to be variable, dependent on prior ENT, RED, RDB, RDS statements, or computations. The 9825A instruction methods are listed in Table B-4.

B-9. Literal Instructions.

B-10. The *"instructions"* term is a literal string of instruc-

Table B-1. 9825A Command Methods.

			ROM Needed	
Literal Commands	10: cmd 7, *"Commands"*		Extended	I/O
Addressing	10: cmd 7, "?U)"		Extended	I/O
	10: wrt 709		General	I/O
Special Command Statements		Command From Table B-2		
	10: trg 709	Group Execute Trigger (GET)	Extended	I/O
	10: clr 7	Device Clear (DCL)	Extended	I/O
	10: clr 709	Selected Device Clear (SDC)	Extended	I/O

Table B-2. Commands.

Command	ASCII	DIO7–DIO1	Decimal	Comments
Selected Device Clear (SDC)	EOT	0000100	4	Scanner Must Be Listening With The HP-IB In The Command Mode.
Group Execute Trigger (GET)	BS	0001000	8	
Device Clear (DCL)	DC4	0010100	20	Scanner Must Be Listening
My Listen Address (MLA)	Table 3-1	Table 3-1	Table 3-1	The HP-IB Must Be In The Command Mode To Address The Scanner.
Unlisten Address (UNL)	?	0111111	63	

Table B-3. 9825A Command Statements.

Command	Statements	
SDC	clr	709
GET	trg	709
DCL	clr	7
MLA	Key Corresponding to MLA In Table 3-1.	
UNL	?	

tions. The CMD statement always leaves the HP–IB in the Data mode. The empty quote field effectively skips the Command mode. An "E" instruction is required at the end of the literal string in the CMD statement to execute the instructions. The WRT statement automatically sends a Carriage Return.

B-11. Computed Instructions.

B-12. The last two digits of the select code may be omitted if the scanner is already addressed to listen. The 7 is necessary as described before. The *instruction* term must be an expression equal to the decimal value of the appropriate instruction in Table B-5.

B-13. Computed Channels.

B-14. The last two digits of the select code may be omitted if the scanner is already addressed to listen. The *channel* term must be an expression equal to one channel number 0 to 79. The format specification is necessary. This method automatically sends Carriage Return and Line Feed characters.

B-15. A decade of channels may be opened by sending the ten's channel digit under an f2.0 format followed by an "execute" instruction. The digit 8 clears decade 0, and the digit 9 clears decade 1.

B-16. Examples.

B-17. Each of the following examples closes channel 36 if the calculator has talk address "U" and the 3495A has listen address ")".

```
1) 10:  cmd 7, "?U)", "36E"      Literal Instruction.
```

Table B-5. Instructions.

INSTRUCTION	ASCII CHARACTER	DECIMAL
Digit	Ø,1,2,3,4,5,6,7,8,9	48 thru 57
Space	SP	32
Clear	C	67
Execute	Carriage Return (CR), E	13, 69
External Increment Off	IØ	73 48
External Increment On	I1	73 49
First Channel	F	70
Last Channel	L	76
Software Increment	S	83
No Operator	NUL, DEL	0, 127
Delimiter	Any other character	1 thru 126*

*With preceding exceptions

```
2) 10:  wrt 709, "36"              Literal Instruction.
3) 10:  wtb 741, 48+3, 48+6        Computed Instruction.
4) 10:  fmt f3.0                   Computed Channel.
   20:  wrt 709, 36
5) 10:  fmt "3", f2.0              Computed Channel.
   20:  wrt 709, 6
6) 10:  fmt 2f2.0                  Computed Channel.
   20:  wrt 709, 3, 6
```

B-18. The following program cycles through channels 1 through 79. The "C" instruction clears the previously closed channel before closing the new channel (break-before-make sequencing). Steps to take a measurement and store the data would normally occur between Steps 20 and 30.

```
10:  for X = 0 to 79
20:  fmt f3.0;wrt 709, "C",X
30:  next X
40:  end
```

B-19. To check channel relays, a known voltage could be applied to every channel (open terminals) and a dc voltage reading taken on each channel. Resistive or open relays can be determined from the stored readings.

Table B-4. 9825A Instruction Methods.

		ROM Needed
Literal Instructions	10: cmd 7, "?U)", "*Instructions*"	Extended I/O
	10: wrt 709, "*Instructions*"	General I/O
Computed Instructions	10: wtb 709, *Instruction, Instruction*	General I/O
Computed Channels	10: fmt 2 f 3.0 20: wrt 709, *Channel, Channel*	General I/O

MANUAL CHANGES

-hp- MODEL 3495A

SCANNER

Manual Part Number 03495-90012

▌ New or Revised Item

ADDENDA

Page 1-2, Paragraph 1-19. Add the following note.

NOTE

High speed switching is intended for burst measurements only. Extensive use of high speed switching places wear on the Reed relays. Reed life is inversely proportional to switching speed and loading.

Page 1-5, Table 1-2. The following supplemental characteristics of the Reeds may be helpfull:

Reed Life (nominal)

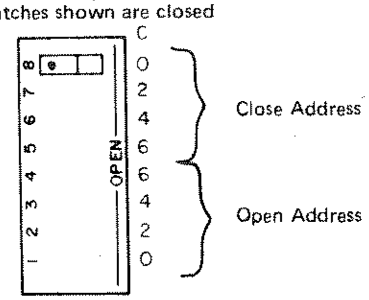
Full Load: $\geqslant 10^6$ Operations
Dry Load: $\geqslant 10^8$ Operations

Page 1-6, Paragraph 1-20. 44404A – 44405A: A modification to the 3495A Power Supply Assembly is required on mainframes with serial numbers 1428A02185 and below if four of these accessories are to be installed. The modification consists of changing A2R8 from .47 ohms to .33 ohms (part number 0812-0066). This change is explained in more detail in -hp- Service Note 3495A-4. Complimentary copies are available from your local Hewlett-Packard Sales and Service Office.

44413: Modifications to the 3495A Line Voltage Receptacle and Filter may be required before installing this accessory in mainframes with serial numbers 1428A02505 and below. The modification improves conducted RFI suppresion to within VDE conducted RFI specifications with the 44413A installed. This change is explained in detail in -hp- Service Note 3495A-3. Complimentary copies are available from your local Hewlett-Packard Sales and Service Office.

Page 3-3, Paragraph 3-35. It may help to label the DIP switches in this paragraph as:

switches positions
switches shown are closed



ERRATA

Page 1-3, Table 1-1. Modify the Option 004 Crosstalk specification into 1 MΩ to be:

100 kHz	1 MHz
< −45 dB	< −45 dB

Page 1-5, Paragraph 1-23. Better definitions of steady-state are dynamic scanner environments would be:

a. **Steady-State Environment:** An environment where the ambient temperature varies no more than 1 degree centigrade per hour (± 1°C/hour).

b. **Dynamic Environment:** An environment where the ambient temperature varies more than 1 degree centigrade per hour (± 1°C/hour), but no more than 5 degrees centigrade per hour (± 5°C/hour).

Page 1-5, Table 1-2. The temperature gradient along terminals from thermistor values may be deleted from this table as they are already properly located in Table 1-1.

Page 2-3, Table 2-1. Options are factory installed according to the following table:

Table 2-1. Factory Installation of Options.
(Installed left to right from rear in listed priority)

Option	Close Address	Clear (Open) Address
004 005	0, 2, 4, 6 Left to Right	≠Close Address
001 002 003	Next Ascending Vacant Decade	≠Close Address None ≠Close Address

Page 2-3, Paragraph 2-34. The last sentence should direct you to Service Group D.

Page 3-5, Table 3-1. The DIO7 thru DIO1 representations for ASCII "(" and ")" characters are out of sequence and should be:

'	0100111
(	0101000
)[1]	0101001
*	0101010

Page 3-11, Paragraph 3-86. Step d. Add an "E" to the end of this example to conform with the others. It should then be:

Example: 2, 2 3 E

Step h. Add an "E" to the end of the first example to conform with the others. It should then be:

Example F 2 1 L 3 2 E

also, "20" in the second example should be shaded.

Step M and N. Shade the numbers in the examples of these steps as they are complete instructions fields.

Page 7-A-4, Table 7-A-1. The part number for A100S1 should be 3101-2216.

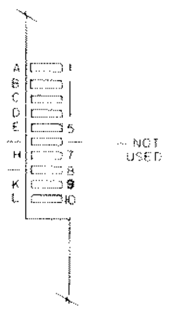
Page 7-A-15, Table 7-A-3. The new power supply assembly, part number 03495-66524, replaces the older version, part number 03495-66502, on instruments with serial number 1428A01626 and above.

Page 7-B-22, Figure 7-B-21. The high and low terminals on the A24 component locator should be switched. Channels are assigned left-to-right in this drawing.

Also, a note on the pin designators on P13. These pin designators apply to the physical positioning of each pin. Don't confuse these

with the pin numbers and letters indicated on the blue cinch connectors (both P13 and J14).

Page 7-C-13, Figure 7-C-12. Renumber the backside pins on P21A on the A21 component locator as shown here:



Page 7-D-10, Table 7-D-1. The third part number in the A40R18 and A40R13 padding lists should have a 0698-prefix rather than a 0757-prefix.

ERRATA

Page 1-3, Table 1-1. Modify the Option 001 High-to-Low capacitance specification with the channel closed to be:

Closed: < 50 pF

Page 1-6, Paragraph 1-29. Change the part number of the Service Kit from 44095A to 03495-69800.

Page 1-9, Table 1-4. Delete the information on the 444195-90000 Operating Note and change the part number of the Operating Note for the Service Kit from 44095-90002 to P-03495-69800-1.

Page 3-12, Table 3-6. The column applying to the Algorithim step "Increment four times" should be shaded.

Page 4-0, Table 4-1. Delete the -hp- 3455A DVM and substitute the -hp- 3403C DVM.

Page 4-1, Paragraph 4-16. Change the relay select switch from a DPDT switch (1) (-hp- 3101-1235) to a 3 position switch (1) (-hp- 3101-1348).

Page 4-2, Figure 4-4. The wiring diagram for A14, Option 001 has channels 5-8 wired incorrectly. The correct wiring is shown here:

Page 4-3, Figure 4-2. The 3 position Relay Select switch is tied to the DVM input, only one type (High, Low, Guard, "A", or "B") of relays are checked in any given position.

Page 4-5, Figure 4-4. The DC Null Voltmeter leads go to High-and-Low common terminals (Options 001, 003, 004, 005) or "A" and "B" terminals (Option 002).

Page 4-5, Paragraph 4-27. Change the relay select switch from a DPDT switch (1) (-hp- 3101-1235) to a 3 position switch (1) (-hp- 3101-1348).

Step a. Delete the sentence: "Use the proper value for R_S as shown in Table 4-2.

Step d. Add this sentence: "Do not test channel 0 on Options 003 or 005 since that channel contains a thermistor from High-to-Low.

Page 4-6, Figure 4-6. The DMM is used in this set-up merely to monitor the *change* and *measure* modes of the HIGH RESISTANCE METER and may be deleted if desired.

Page 4-6, Paragraph 4-29. Modify the Option 001 High-to-Low capacitance specification with the channel closed to be:

Closed: < 50 pF

Page 4-7, Paragraph 4-31. When making capacitance measurements, minimize lead lengths to the measurement terminals. Because of differences in the options, the capacitance specifications are derived somewhat differently for each and should be checked as follows.

High-to-Low

Option 001. Measure at the channel *input* terminals

Option 003. Measure at the channel *common* terminals

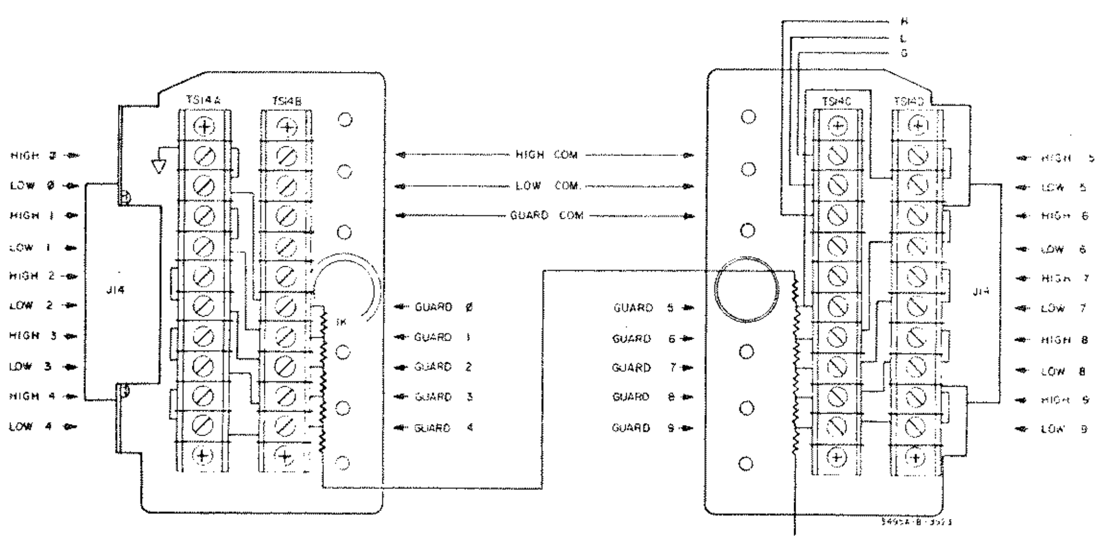
"A"-to-"B"

Option 002. Measure on either side of actuator relay.

Interchannel

Option 001. Measure from High-to-Hign and Low-to-Low between adjacent channels with one closed. Measure at the channel *input* terminals.

Option 002. Measure from "A"-to-"A" and "B"-to-"B" between adjacent channels with both closed.



A14
hp Part No. 03495-64101

Option 003. Measure from High-to-High and Low-to-Low between adjacent channels with one closed. Measure at the channel *input* terminals.

Page 4-8, Paragraph 4-37. Substitute an -hp- 3403C DVM for the -hp- 3455A DMM.

Page 4-9, Paragraph 4-37, Step c. Remove the TRIGGER, AUTO CAL, and GUARD PORTIONS of this step as they do not apply to the recommended DVM.

Pages 4-9/4-10, Paragraph 4-37, Steps e, I, o. Adjust for a DVM reading of 3.00 volts.

Performance Test Card, Page 4. Change the Option 001 capacitance specification with the channel closed to be:

Closed: $<$ 50 pF

Page 7-16, Paragraph 7-62. The part number for the Fixture Cable Assembly used in this procedure should be 03052-61501. This cable is refered to on page 7-17 as well.

Page 7-A-4. The part number for the Front Trim Retainers is 7101-0326, quantity of 3.

Page 7-A-15. The new ROM, A4U16 (-hp- 1816-0895) replaces the old ROM, A4U16 (-hp- 1816-0587) for serial numbers 1428A00736 and above.

Page 7-D-12, A41. The part number of an individual coil is 9140-0275 (2 per channel) and the part numbers for a core is 9170-1106.

A42. 03495-81901 is a package of 21 tested reeds (7 channels). The part number of an individual reed is 0490-1156.

Page 7-E-7. SA Test Set-Ups. The jumpers which must be opened to implement SAØ are J3 - J10.

Page 7-E-7/7-E-8, Figure 7-E-4. The jumpers which must be opened to implement SAØ and reinstalled aferwards are J3 - J10. The clock for SA1: Configuration 1 should be set for a *positive* edge. If an incorrect +5 V signative is obtained for SA1 and the test configuration is correct, go to the point in the flowchart labeled: "Begin Actual SAØ Routine" to check the ROM and processor circuitry.

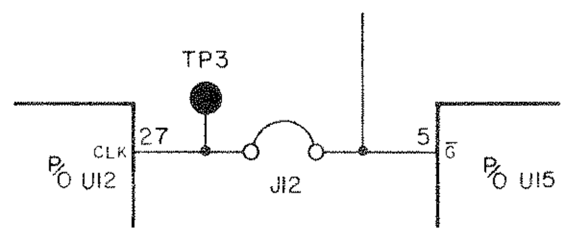
Page 7-E-10, Table 7-E-1. Change the part number of A8U12 to 03495-62501 (NANOPROCESSOR ASSY). The correct padded value of A8R29 is included with this kit to simplify service. Also, the part number for the ROM, A8U10, is 1816-1171. The Mfr part number for U1, U3 - 5, U8, U11, U13, U14, U16, U17, and U18 should be "LS" series TTL not "L5".

Page 7-E-11/7-E-12. The signatures for A8U7 in SA1: Configuration 1 have incorrect values for pins 9 and 15. The correct signatures are:

9	HFPA
15	4P4F

These signatures should also be changed if the first block on Page 7-E-9, Figure 7-E-4.

The location of TP3 should be changed and J12 added as shown below:



A8R26 should be labeled 100 Ω not 499 Ω.

The padding List for R29* should have the −5 V and −2 V part numbers changed both on the schematic and in the parts list to be:

−5	20 K	0757-0449
−2	649	0698-4460